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Vol. 147 SATURDAY, MARCH 8, 1941 No. 3723

CONTENTS

PAGE

Science, Politics and Government 275

International Cultural Relationships 277

A Zoology for Students. By Prof. C. H. O'Donoghue 278

A History of Mycology. By J. G. Crowther 279

Teaching Physics. By Dr. W. H. George 280

Methane as a Fuel 281

Foundations of Tropical Agriculture. By Prof. C. W. Wardlaw 282

The Foundations of Empirical Knowledge. By Prof. Herbert Dingle 286

Obituaries:

Prof. H. S. Hele-Shaw, F.R.S. By Prof. A. H. Gibson 290

Sir Pendrill Varrier-Jones. By Sir Walter Langdon-Brown 290

Prof. V. Putti. By Dr. J. D. Rolleston 291

News and Views 292

Letters to the Editor:

Linkage between the Repeating Units in the Starch Molecule—Prof. C. C. Barker, Prof. E. L. Hirst, F.R.S., and G. T. Young 296

A New Method of obtaining the *N* Pattern of Electron Diffraction—Shigeto Yamaguchi 296

Magnetization of Matter by Light—Prof. Felix Ehrenhaft and Leo Banet . . 297

Zinc Oxide Smoke—G. D. Preston 298

Weighing Living Marine Animals—A. G. Lowndes 298

Science and Government—Dr. E. C. Childs; Dr. Otto Blüh 298

Research Items 300

The Australian National Standards Laboratory. By Sir David Rivett, K.C.M.G. . . 302

Colour Tolerance 303

Electrically Driven Ships 304

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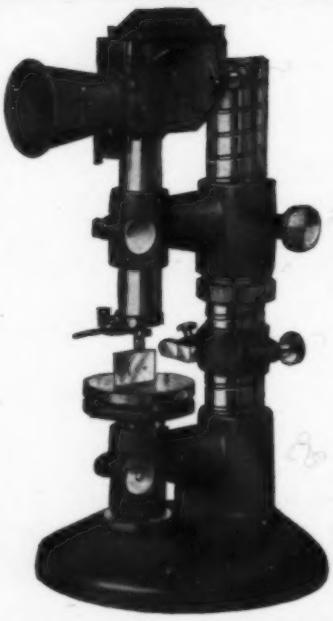

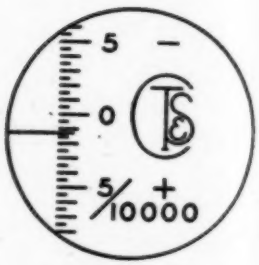

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Vol. 147 SATURDAY, MARCH 8, 1941 No. 3723

SCIENCE, POLITICS AND GOVERNMENT

THE multitudinous ways in which science and its applications impinge on everyday life are apparent, as never before, to every thinking man. That it has required a major disaster in the form of a world war to bring about this realization is not to the credit of civilized people, but the fact should be faced that there is now widespread appreciation of the use—and misuse—which is being made of scientific knowledge. On the credit side must be placed the advances made in medical science as the result of the discovery of new treatments and new synthetic drugs, and the steps which are now being confidently taken to meet the nutritional needs of the nation in the absence of foodstuffs hitherto mainly imported from abroad, quite apart from the general rise in standard of living and increase of amenities to which we have grown accustomed in happier times. On the debit side there is the whole range of horror provided by modern warfare, based on scientific and engineering developments utilized for the destruction of man.

While this much will readily be conceded, there is not so general a concensus of opinion as to the part which science should take in the reconstruction and re-ordering of the world which will follow the end of the War. Correspondence which has been published in NATURE makes this point clear, and the differences of opinion are not only between scientific worker and layman but also among scientific workers themselves. One school of thought believes that science should be a discipline apart from worldly affairs, a disinterested pursuit of truth. Thus Prof. M. Polanyi has protested against a remark in an article in these columns to the effect that science can no longer be regarded as possessing "a peculiar holiness" setting it apart from other social interests. He has been answered by Dr. C. H. Waddington, who puts the case for utilizing scientific method over a wider field than that in which it now functions. Mr. R. H. F. Finlay has pointed to the success attained by chemical and engineering enterprises guided by scientific methods, and asks that science should take control in aspects of government in which it is competent. Dr. V. B. Wigglesworth interprets this as a suggestion that science should actually govern ; he asks if that would not be a definite threat to the freedom of scientific research, and states his belief that "the function of science in the national economy . . . is advisory". Elsewhere in this issue (pp. 298, 299), Dr. O. Blüh gives his views on reactions to planning in Central Europe during the past decade, and Dr. E. C. Childs points out some of the difficulties of applying experimental methods in this field.

This great diversity of opinion is evidence that the problem of the relation of science to society is still very much to the fore. It must be approached in a scientific manner ; in other words, the data should be gathered, deductions made and tested for consistency and when necessary scrapped, before action is taken. Admittedly, this is no easy task. Scientific men are but human, subject to prejudices like other men, though their training should enable them to recognize more readily when prejudice steps in and reason is put aside.

The fundamental point on which all can agree is that science represents the search for truth, for ever-increasing knowledge of the universe. It is inconceivable that this continuous probing of the secrets of Nature can ever be suppressed, even although circumstances may force it into the background for a while. In due time, some of the facts collected in this way come to have a direct influence on the lives of men, and in this way progressive civilization has been built up. We have

now reached a stage when the contribution of science to everyday life has become a major one.

But in arriving at the present position, the conditions under which scientific research goes on have changed radically. The days of the natural philosopher pursuing his leisurely inquiries, perhaps alone, perhaps with one or two chosen disciples, have gone. Modern investigations are carried out for the most part in well-equipped laboratories attached to universities or large industrial concerns, while field-work often involves substantial expeditions. Although important discoveries are still made by the individual working with the minimum of apparatus, this method has become the exception. The tempo of research has increased and with this acceleration has come the team of investigators working together on different aspects of the same or allied problems.

Thus research has become to a large extent conditional on financial support, which has come in increasing amounts in recent years from State resources. As the fruits of scientific discovery in the long run lead to a higher standard of living and are of service to the nation as a whole, it is right that the State should contribute funds for this purpose; but this must not be allowed to endanger the freedom of the man of science to seek and to teach the truth. The administrative body can retain general control without allowing political, racial or religious views to influence the course of investigations or to falsify their results. The best method of exerting such control is still an open question, but it is fairly obvious that representative scientific bodies should take a prominent part. An experiment in this direction was the appointment last year of the Scientific Advisory Committee, which reports directly to the War Cabinet. This body, consisting of officers of the Royal Society and of the State research departments, is, of course, a war-time expedient, but it represents the kind of directing influence which should always be present in the Government, not only to formulate policy on the provision of funds for research, but, even more important, to deal with those numerous problems in which science impinges on human welfare both in war-time and in times of peace. Politicians may have special training and aptitude in the art of government, but they cannot be expected to appreciate in full measure the significance of scientific developments, or to foresee the course of events where the application of scientific knowledge is concerned. Here, then, science should have a place in the government of the country—not to deal with affairs of which it can claim no special knowledge, but with those in which it is particularly competent. It remains for the future to decide the precise manner in which science should be represented in the Government.

Closely entwined in the arguments for and against the participation of science in public affairs, are frequent references to the social responsibilities of science and scientific men. This theme has been discussed many times in these columns. In brief, it comes to this: the scientific worker must seek after truth, but he should not be saddled with the whole responsibility for the misuse often made of it by others. Nevertheless, he should, through his own organizations and individually, press for such appreciation of the true worth of science as would prevent its misuse. It may be argued that it is too much to expect to eliminate the individual, or the State, which would endeavour to exploit discoveries selfishly or without regard for the welfare of mankind, but at least the attempt would be worth while, and it would bring nearer the day when such an individual or State would be outlawed by mankind.

It is perhaps in this wider field of international affairs, paradoxically enough, that the influence of science has produced its most tangible effect. As Prof. A. V. Hill showed in his recent address to the Parliamentary and Scientific Committee (see NATURE, March 1, p. 250), international congresses for the discussion of progress in various fields of scientific endeavour have been effective instruments in promoting progress and understanding. Further, as has frequently been emphasized in these columns, the achievements of the scientific and technical services of the League of Nations have marked a noteworthy stage in international collaboration.

Scientific men, working in their own fields, have given a wide significance to the phrase 'science and society'. They have shown that they can rise above political considerations in affairs of the State and internationally, to the lasting benefit of humanity. 'Science' has, indeed, become inseparable from 'society'; one is dependent on the other. On the part which is played by science—using the word in its widest sense and including the inquiring and unprejudiced approach which should be characteristic of scientific investigation—in determining world conditions after the end of the War will depend the stability of international affairs by which alone civilization can flourish.

INTERNATIONAL CULTURAL RELATIONSHIPS

THE concentration which all the sources of publicity during a period of crisis must give to the War tends to diminish proper and adequate comment upon other activities within the country. It may be for this reason that but little notice has been taken of a remarkable document entitled "Greece No. 1 (1941) Convention between His Majesty in respect of the United Kingdom and His Majesty the King of the Hellenes respecting the Relations of Learning and Culture between Great Britain and Greece"*. Yet this Treaty should not go unregarded, for it marks a notable development in British relationships with foreign countries. It is a Treaty not of war and peace, nor of commercial bargaining; it is uncontaminated with the breath of propaganda; it is an attempt in an honest and unequivocal way to develop the relationships of thought and mind, of literature and science, between two great civilized peoples.

There is a dramatic propriety in the fact that the first Treaty of this kind to which Great Britain has given her signature should be with Greece. The contact of British civilization with that of Greece extends for centuries, and the basis of much of British education has been upon the classical language of that country; while from a more immediate consideration, in this hour when the face of history is being changed, Greece has been an ally that has shown that the forces of totalitarianism can be faced by resolute mind and an equal resolution in arms. Behind this document there is further a certain atmosphere of tragedy, for the signature with which it concludes is that of General Metaxas, a great friend of Great Britain, and one who had always encouraged British cultural institutions as they developed in Grecian territory. Further, though his signature nowhere appears, it is common knowledge that on the British side the initiative for this cultural bond came from that dynamic personality, Lord Lloyd, who, through the British Council, was transforming the cultural relationship of Great Britain with foreign countries.

The articles of this Treaty are modest enough. Cultural institutions in the two countries are to be given all proper encouragement and possibility for development. Students and professors and men of learning are to be welcomed equally in London and in Athens. Further, an attempt is being made to ease the entanglement of university regulations which have hampered the passage of students from one country to another and made less easy that fraternity of scholarship which existed in the Middle Ages. Above all, the British traffic of the mind in books and periodicals is to be promoted with as little impediment from customs duties, import quotas and other "relevant regulations" and all such taxes upon knowledge as may be possible.

It is particularly welcome that this Treaty of culture is not confined to any single branch of learning, but that science is to be encouraged along with art and letters. The British Council has already anticipated the action proposed by the Treaty in bringing to Great Britain a number of young Greeks, some of whom are still in British universities, and among them there are young men of science whose work has been reported as reaching a high level of distinction. Nor are the signs lacking that the British Council fully realizes that its definition of culture must include British achievements in medicine and engineering and the pure sciences, and that in due course it must organize the best of expert opinion in Great Britain to break down any intellectual insularity that may still remain. The Treaty belongs to the things which are permanent and will not only survive the War but will also become more active and real once this conflict is over. We live to-day in the sullied atmosphere of propaganda, and it may be that under the conditions of modern warfare that is inevitable; but when peace comes it is through instruments such as this cultural treaty with Greece that British contact with foreign countries should be based.

The pressure of war allows but little leisure for tributes to be paid to the dead, and the individual is likely soon to be forgotten in the major stress of events. In the few pages of this convention there remains a tribute to Lord Lloyd which should encourage those who are engaged upon the work of the British Council to increase their endeavours, and should make Great Britain affirm that in the future it will carry the best that its learning, both in the sciences and in the humanities, can give to all free peoples who may welcome such a proper and uncontaminating contact.

* H.M. Stationery Office, 2d.

A ZOOLOGY FOR STUDENTS

A Text-Book of Zoology

By the late Prof. T. Jeffery Parker and the late Prof. William A. Haswell. Sixth edition. Vol. 2. Revised by Dr. C. Forster-Cooper. Pp. xxiii + 758. (London: Macmillan and Co., Ltd., 1940.) 36*s*. net.

WE can now welcome the appearance of volume 2 of the new "Parker and Haswell" (volume 1 was reviewed in NATURE of October 5). It is the volume dealing with the Chordata, a phylum in which important advances in our knowledge of both fact and theory have been made and needed incorporation to bring it up to date. Its format, like its companion volume, is larger than that of the previous five editions, the last of which was published in 1930, and the type is slightly larger. The pages number 758 as against 683 of the previous edition. More space has also been gained by the omission of the two general chapters on distribution and philosophy. Older readers will perhaps regret the loss of these, but, however much they might have desired their retention, it is fair to say they only represented a résumé of our knowledge on these topics forty-three years ago. It is justly pointed out in the preface that to have brought them up to date would have involved their expansion, and consequent enlargement of the volume beyond reasonable bounds. The space thus gained has been used for the incorporation of a very considerable amount of recent information.

It must not be thought that this edition is simply the last with additions; it is reorganized, largely re-written, and to a considerable extent re-illustrated: it is in effect a *new* edition and not simply a revision. A large number of the old illustrations have been excluded and new ones, including some excellent photographs, added, and of these about thirty appear to be published here for the first time. Although they are fewer in number (656 as against 1,169) they actually form a more useful collection, and the standard of reproduction is throughout excellent. Perhaps the most serious criticism regarding the illustrations is the retention on p. 350 of Wiedersheim's very diagrammatic and not accurate representation of the venous system of Salamandra when more precise information is available. Three diagrams of the suggested phylogenies of the fishes, the reptiles and the mammals plotted against the geological periods as a time-scale form useful additions, as many students gain a clearer idea from such schemes than they do from any amount of straightforward text.

The text-figure legends are fairly uniform and unusually commence with the scientific name in black face type unless the subject requires other treatment. The same consistency has not been maintained with regard to nomenclature, and it is rather curious that well-known names have been rejected, correctly, of course, in some instances, whereas in others they have been retained. Thus, to take a few examples, Bdellostoma becomes Eptatretus, Scyllium becomes Scylliorhinus, Echidna becomes Tachyglossus, Galeopithecus becomes Cynocephalus; but, while Ceratodus becomes Epiceratodus in the heading of the section, it remains Ceratodus in the text. On the other hand, Branchiostoma remains Amphioxus, *Lampetra fluviatilis* remains Petromyzon and *Oryctolagus cuniculus* remains Lepus. While on the subject of names, the diagram on p. 188, in which a spine is clearly indicated on the anterior margin of the anterior dorsal fin, is surely that of Squalus, although it is labelled Brachælurus. This question of correct naming is important in a students' text-book, for any incorrect names that are acquired in early years are liable to persist in an amazing way: it is just as easy for the beginner to learn the right name. In line four from the bottom of p. 460 Neornithes should read Neognathæ. On p. 639 it is stated that the mammary glands are modified "sebaceous glands": why not say sweat glands, since that has been established beyond reasonable doubt by various workers, and the mode of producing secretion differs fundamentally in the sweat and sebaceous glands?

In correspondence with the unequal rate of advance in our knowledge of the fundamental facts in different groups, varying amounts of revision have been necessary in dealing with the different classes of the Chordata. Least alteration is noticeable in the Hemichorda, Urochorda, Amphibia and Aves. The sub-phylum Agnatha, the Pisces, Reptilia and Mammalia on the other hand, have been far more drastically treated, and it may be said at once that this is a much needed improvement. In the first three in particular considerable stress has been laid on the palæontology of the groups. Some knowledge of the palæontology is, of course, essential to the understanding of the relationships of the living groups, since they are but the end twigs of a tree the main branches and trunk of which can only be revealed by this method of approach. On the other hand, it is true

that many students of zoology unfortunately have no knowledge of geology, and they can never hope to see many of the types dealt with, or, if they did see them, they would be quite unable to interpret them. It is in the groups that they have been most critically re-written that palæontology has made the most conspicuous contribution to our knowledge, and it is fortunate that the revision has been made by an acknowledged master in that field. The volume is furnished with an exceptionally full index.

Here then we have the completion of the new "Parker and Haswell" arisen Phœnix-like out of the ashes of its former self, the good features remaining, but embellished and burnished by its ordeal of fire. Such a thorough revision has long been needed, and it has been carried out in a most praiseworthy manner. Students for some time to come will have reason to thank both the revisers of the volumes and the publishers for once again firmly securing "Parker and Haswell" on its pedestal as the most useful text-book of its size and compass in the English language. It is a pity that the price is so high, each volume costing as much as the two volumes did in the original edition, but for that the publishers are not to blame. It is due to causes not under their control, and, compared with other advanced text-books, it is certainly good value for the money.

C. H. O'DONOGHUE.

A HISTORY OF MYCOLOGY

The Advance of the Fungi

By E. C. Large. Pp. 488 + 6 plates. (London: Jonathan Cape, Ltd., 1940.) 18*s*. net.

THIS very interesting book is a history of research on plant diseases, especially those due to fungi. It is written in the new style, in which the events of the history of science are related to their social background, and it contains much fascinating material.

The author begins with an account of the potato murrain. Its appearance in England was noted in August 1845, and at once received the attention of the leading botanists, including Dr. John Lindley and the Rev. M. J. Berkeley. Within a few weeks, news of the spread of the disease came from Poland, Germany, Belgium and France, and from nearly all parts of England.

There had been a peculiar change in weather during the summer. The early period had been fine, with temperature above the average, and had then been suddenly followed by three weeks of exceptionally damp and cold weather. Many botanists, with Lindley at their head, believed that the bad weather caused the plants to be overladen with water. This produced a sort of dropsy, and putrefaction. Berkeley, on the other hand, was impressed by the mould observable on the diseased plants, and suggested that it was the cause and not the consequence of the disease.

This raised once more the conception of the nature of disease in general. Were diseases intangible entities or were they due to concrete causes that could be seen and controlled? It is notable that Berkeley, the Christian clergyman, was the most resolute in the rejection of all nebulous and transcendental explanations of disease, while the more materialistically minded men of science were the most eager to espouse them.

This wonderful man was of commanding presence and robust physique. He was educated at Rugby and Cambridge. He was a perpetual curate, and maintained a large family on a very small stipend. He had to take in pupils to increase his means, and he was active in his parish. He was a good classical scholar, and read all the proofs of the "Genera Plantarum" by Bentham and Hooker. He was the leading authority in England from 1836 until 1870 on fungi. He collected a herbarium of ten thousand species of fungi, which was ultimately acquired by Kew, and he described nearly six thousand new species. Finally, he retired on a minute civil pension.

While the potato murrain was stimulating researches that helped to transform the conceptions of plant disease, and consequently of human disease, it was an instrument in profound political changes. Sir Robert Peel was seeking plausible reasons at the time for the repeal of the Corn Laws. The murrain attacked the Irish potato crop and destroyed the food of a large section of the Irish population, and Peel found in this event most moving arguments for free imports of corn. Thus the potato murrain was a trigger which released Britain on her career of free trade in the nineteenth century. Some details collected by the contemporary *Times* reveal the conditions of the Irish labourers. The annual wages were about £3 18*s*. A pig worth about £4 was reared, making an annual monetary income of about £7 18*s*. From

this, about £5 rent was paid, leaving £2 18s. to buy meal, clothing, tools, candles, medicine and drink for the year. The food consisted almost entirely of home-grown potatoes, each person eating from eight to fourteen pounds per day.

The fungi of the potato murrain advanced with vengeance on the Irish population. Relief measures became imperative, but they were conducted with a meanness that has left a scar. Are we not now having to pay for such errors?

Among the many interesting sections are accounts of the researches of the Tulasnes, Tillet, and de Bary. The Tulasnes were devout Catholics who made wonderful drawings of fungi in order to reveal the beauty and infinitude of the Creation. Their researches were dedicated to the glory of God, and in their zeal they sometimes saw things that did not exist; but this was trivial compared with the discoveries they did make. The metamorphoses of the fungi were very complex, and their obstinate belief in the subtlety of Nature liberated the imagination of the men of science, and assisted them to discover the almost incredible series of changes.

Tillet's brilliant researches in 1751 on bunt in wheat, with his one hundred and twenty adjacent plots containing differently treated seed, so that the results on each could be compared, are described; and the exact researches of the acute and intelligent twenty-two-year old de Bary in 1853.

The later sections of the book on such subjects as chemical fungicides are not less interesting.

There is one subject, however, in which the author is perhaps a little unfair. He writes hard words about Lyon Playfair, who was consulted on the problem of the potato murrain in Ireland, and gave advice that was of little scientific value. He was a chemist, and did not know much about fungi, and he was also a free-trade individualist particularly anxious that the relief for the starving Irish should not undermine the individualistic strand in their moral fibre.

Playfair's performance on this occasion was not one of his happiest; but in other directions he gave the most signal service to science. The success of the Exhibition of 1851 and the fruits of the scientific institutions founded with its profits are largely due to him, and his combination of scientific knowledge with political skill was, on the whole, of great value. He was one of those rare statesmen of science who could coax, wheedle or bully governments into making more use of science, and more of his type would be very useful to-day.

J. G. CROWTHER.

TEACHING PHYSICS

The Demonstration Laboratory of Physics at the University of Chicago

By Prof. Harvey B. Lemon and Fitz-Hugh Marshall. Pp. iv+127. (Chicago: University of Chicago Press; London: Cambridge University Press, 1939.) 9s. net.

THE reactions of scientific workers to war are in one respect like those of all normal men. Self-preservation comes first; after that, some can think only of bigger and better destruction. A book dealing with so constructive a process as education in the physics laboratory can have little present interest for them. However, for those who both turn and escape from destruction to construction, the book has a very special interest.

Teaching physics is a new subject. When J. J. Thomson first began in the early 'seventies, there were only six physics laboratories in England. Now there are more than three hundred. Their rapid growth has been haphazard. Courses in practical physics were planned to train students both to use physical apparatus and to understand theoretical physics. The dual purpose of using practical physics to train both hands and head has resulted in a tradition in the universities that each student must spend many hours each week in the physics laboratory. To what extent this is necessary is doubtful. Workshop and glass-blowing bench give better hand training. Practical physics of the teaching laboratory is an inefficient way of training hands. For students who follow instructions as if they were cookery recipes, it is no better trainer of the head. In the Ryerson Demonstration Laboratory of Physics at the University of Chicago, Prof. H. B. Lemon and Dr. F.-H. Marshall have broken with tradition by providing, in effect, the maximum training of the head with the minimum of hand. About 240 experiments covering all the main phenomena of physics from inertia to X-rays and cosmic rays are completely set up in more or less permanent form so that they 'work' without fail or fake.

The laboratory started as a physics museum for showing physical phenomena rather than historical apparatus. The equivalent in Great Britain is in that small part of the Science Museum exhibits at South Kensington to be found, oddly enough, in

the children's section in the basement. Plans, very clear photographs and notes enable the physicist easily to visualize the Chicago laboratory. The authors give also a thorough discussion of its different uses. Over a period of seven years about 40,000 students and visitors have seen and used the experiments as part of introductory general courses or 'surveys', as preparation for the equivalent of the Intermediate B.Sc. and 1st M.B. courses, or as part of the training of teachers. Public 'open evenings' have also enabled citizens of the community around the University to observe physical phenomena directly instead of merely reading about the rather mysterious physical universes presented to them, with or without alleged theological implications, in popular science literature.

While the demonstration laboratory gives the student little practice in laboratory techniques, it must be remembered that the majority of those studying physics in a university never become physicists. There can be little doubt that developments as striking as those of biochemistry will be made wherever two sciences overlap. A biophysicist, for example, will have to know all the main phenomena of physics, chemistry, botany and zoology. The demonstration laboratory would help in acquiring the knowledge quicker than would the ordinary practical laboratory, and the time saved could be spent upon mathematics and upon the specialized laboratory techniques actually needed for future use.

This volume can therefore be very strongly recommended to the attention of all concerned with teaching any of the sciences. To the reviewer it carries deeper significance. The object of the laboratory to which it directs attention is "first-hand contact with the phenomenological source material of the science", that is, with observable facts. These are the only things in which agreement between human beings has ever, so far, been reached. While the men of action are urging mankind on in a struggle for *unobservables*, values and the like, the ineffectual intellectual may well wonder if the ideas behind the Chicago demonstration laboratory—the stressing of *observables* in which men agree—may not lead to greater human happiness.

W. H. GEORGE.

METHANE AS A FUEL

Methane

Its Production and Utilization. By Dr. J. P. Lawrie. Pp. 66. (London: Chapman and Hall, Ltd., 1940.) 6s. net.

AT the present time there is very little natural petroleum in Great Britain, and the country is almost entirely dependent upon imports for supplies of fuel oil and petrol. In this book Dr. J. P. Lawrie has shown that there are available substantial quantities of methane gas which, if used as an alternative to petrol, could replace a large proportion of the fuel at present being imported.

Methane occurs in coal deposits, and is released as fire-damp when the pressure of overlying deposits is eased during mining operations. While there are no actual figures obtainable of supplies of gas available from the blow-holes of mines, Dr. Lawrie instances two mines which produce 10,000,000 and 1,000,000 cubic feet of methane per day. As there are 1,250 collieries in Great Britain, there is no doubt that the total quantity of gas available from this source is substantial. At the present time all the methane from mine blow-holes is wasted, and while private enterprise is aware to some extent of the value of these supplies, little can be achieved until a survey is made by an official body.

Methane is also found associated with oil, and the recent search for petroleum in Great Britain has indicated that supplies of the gas are available from this source. For example, in Scotland there is a site from which 12,000,000 cubic feet of practically pure methane can be obtained per day. Quantities have also been revealed in borings in Derbyshire, Sussex, Yorkshire, and Lancashire.

Apart from these natural occurrences, methane can be obtained from the treatment of coal, from ordinary coal gas as supplied for towns' use, coke-oven and water gas. Production from these sources, however, involves the utilization of an existing fuel. Thus, in relieving the demand for petrol by the manufacture of gas, either an indigenous or an imported fuel is being consumed. In war-time, particularly, the relieving of one shortage might merely have the effect of causing another. There is, however, another source not falling within this category, and that is sewage. Dr. Lawrie is of the opinion that the production of methane by the digestion of sewage sludge offers the most satisfactory source, apart from supplies from natural sources. Summarily, he calculates that quantities of methane from all known sources can supply not less than 7 per cent of the country's peace-time requirements of fuel substituting petrol.

FOUNDATIONS OF TROPICAL AGRICULTURE

By PROF. C. W. WARDLAW,

UNIVERSITY OF MANCHESTER (FORMERLY OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE)

"'You must certainly have a vast estate,' said Candide to the Turk.

"'I have no more than twenty acres of ground,' said he, 'the whole of which I cultivate myself with the help of my children; and by our labour we avoid three great evils, idleness, vice and want.'

"'Elevated stations,' said Pangloss, 'are very dangerous, according to the testimonies of almost all philosophies.'

"'I know,' said Candide, 'WE MUST CULTIVATE OUR GARDEN.'"

VOLTAIRE.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD

Via cilendi haud facilis

THE Imperial College of Tropical Agriculture in Trinidad was founded as the West Indian Agricultural College in 1921, to provide instruction in tropical agriculture and in the cultivation and preparation for market of tropical produce of every kind, and also to continue the work of the Imperial Department of Agriculture for the West Indies. In 1924 the name was changed to "The Imperial College of Tropical Agriculture". Two years later the College was incorporated by Royal Charter, and in the following year it received the patronage of M.H. the King. It is now the recognized centre for post-graduate training in tropical agriculture for the agricultural services of the Colonial Empire.

THE OLDEST INDUSTRY

As an institution for teaching and research the Imperial College of Tropical Agriculture is still in its first youth. Yet its roots are deep, for it has assimilated to itself the oldest and most honourable traditions in the world: man's need to till the soil and make it bring forth abundantly.

The way of the cultivator is hard. In the realm of agriculture man enjoys at best but a qualified success. In the Middle Ages, when famines and plagues periodically swept the face of whole continents, the heart-breaking vicissitudes of agriculture were recognized and passively accepted as being something in the nature of things, to be tolerated with patience and fortitude. To-day we still recognize the endless complexities and difficulties of agriculture, but our mood is no longer one of submission: we know that its problems, be they ever so complex, are not insoluble. With the passage of time science, in her many forms and even in her youngest branches, has been recruited to the aid of the oldest industry; over the whole world agricultural industries are being succoured and assisted as never before. Resignation in the face of famines, plagues and kindred agrarian mishaps, is no longer conceivable. The combination of the methods of science with the age-old art of the cultivator constitutes a new and unprecedented phase in human endeavour, and we strive with the heartening assurance that in spite of all difficulties we shall yet venture through adversity to success.

FROM CANCER TO CAPRICORN

The citizens of medieval Europe who used spices from the distant Orient to preserve and give flavour to their food, and knew something of the strange exotic merchandise that came by caravan and quinquereme from the vast and little-known world beyond the Mediterranean basin, were yet entirely unaware of the enormous wealth that remained—and, be it said, to this day still remains—to be exploited in the tropical belt. That a swamp reed with a sweetish sap would one day be the basis of a major industry the world over; that bananas, in whose shade wise men of the East sat in pious contemplation, would give rise to a marvellous industry in the New World; that citrus fruits from the Orient would find their way to all lands where the hot sun beats down; and that the many new plants, maize, potatoes, tobacco, to mention only a few discovered by the Conquistadores in the New World, would become infinitely valuable sources of food in the Old: all these, and a hundred others, of the wonderful possibilities that lay untouched between the bounds of Cancer and Capricorn, were unknown to our medieval ancestors, yet but awaited the day when men would set out in search of new lands, to bring back undreamed-of spoil.

More often than not the gold that the Conquistadores sought with such incredible energy and ferocity failed to materialize. Nor, with some rare exceptions, did they realize that the real and enduring value of their discoveries and conquests lay, not in mines, but in those vast tracts of rich agricultural territory found by them in that equatorial belt which imaginative geographers have described as the Torrid Zone. Here, indeed, in the

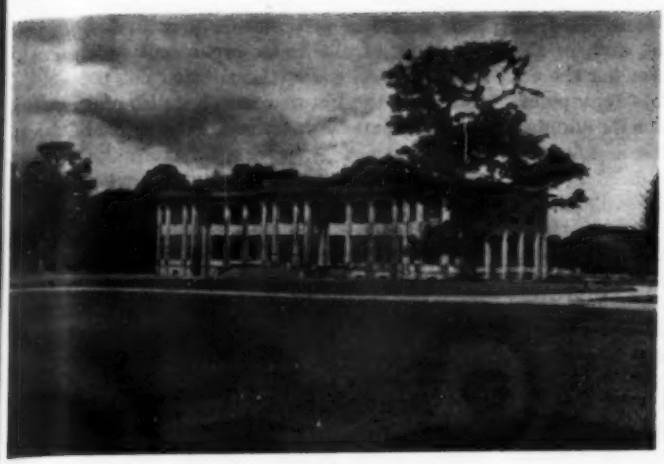


Fig. 1.
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE: MAIN BUILDING.

newly found realm of tropical agriculture, was wealth personified, a veritable El Dorado for the unnumbered generations that would come after.

RAISON D'ETRE

From Cancer to Capricorn, whether deluged by tropic rain, or starved for water, lies a vast area of which the potential productiveness of the food and commodities that men require has scarcely begun to be realized. But already, because mankind tends to blunder on its myopic way by a process of trial and error, there is much in the sphere of tropical agriculture that is faulty, wasteful and inefficient, and which represents an abuse both of opportunity and material—this in an industry the welfare of which is of fundamental importance to all. For posterity as for our own generation, for all the many peoples scattered over the face of the earth, it is now recognized that the vast resources of the tropics should be treated in no haphazard fashion but should be afforded all the advantages of the accumulated knowledge of agriculture, the steadying guidance of an enlightened administration, and the unstinted assistance of science. To this end the Imperial College of Tropical Agriculture was founded, that its students should go forth to disseminate a new knowledge and idealism to the farthest ends of our great Colonial Empire.

AMENITY

For those to whom the tropic urge has proved irresistible it would indeed be difficult to begin a career in circumstances more favourable than those provided at the Imperial College of Tropical Agriculture. A green and pleasant land, Trinidad provides good living conditions, ample scope for recreation, a wide variety of interests, and, not least, a friendly and kindly people whose hospitality is unstinted. If a man be at all adaptable, he can find in Trinidad most of the things that make for happiness and a sense of life well lived. There must, indeed, be few places in the tropics of which as much can be said.

Although it is now more than four hundred years since the first European visitors went to the shores of an island which the aboriginals called Iere—the 'Land of the Humming Bird'—Trinidad is still unspoilt, and for those willing to explore, is a land of adventure and romance. From coast to coast a marvellous profusion of vegetation greets the eye; untouched virgin forests still brood with the solemnity of a thousand years, and the vast gleaming swamps are bright with the plumage of wild fowl. Tucked away in a fold of her green mantle, Trinidad hugs to herself one of the wonders of the world—the Pitch Lake where Sir Walter Ralegh once caulked his ships. Which thought almost tempts us into the byways of digression, for Trinidad possesses a background of remarkable

Fig. 2.
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE: FARM BUILDINGS.

historic interest. Conquistadores were there in olden days, in search of El Dorado, and, in the murky waters of the Orinoco that lave her shores, many hard-fought naval engagements took place. As to her peoples, the island has become the adopted home of many nationalities, and life is colourful and interesting in proportion.

And so we come to the College.

Almost like a university with its atmosphere of detached calm, the College buildings, solid, dignified and with a sense of spacious repose, are set on an expansive savannah, a green pasture, kept trim and orderly, to which shapely angeline and saman trees lend an impression of coolness and grace. Round the savannah are various red-roofed laboratories, students' hostels and staff houses, while beyond, the eye rises to a densely wooded mountain-side cleft by deep valleys, with a Benedictine monastery perched in high seclusion.

Didactic

The young men destined for the Colonial Agricultural Service are selected with great care from home and dominion universities and from agricultural colleges. As a rule they have already taken an honours degree in science or agriculture, but personality, social qualifications and physique are also considered essential for a service that is as exacting as it is many-sided.

After a year at the Cambridge School of Agriculture, the cadets proceed to Trinidad for a final year of studentship, which initiates them into a great service—the Colonial Agricultural Service. For most of them it must indeed be a wonderful year. The glamour of the tropics, the strange and varied experience of living in a new country peopled with many races, and, not least, the feeling that they are at length coming to grips with their life-work.

The principal function of the College is the instruction of students in tropical agriculture and methods of research relevant to modern agricultural requirements. Accordingly, a closely knit course has been built up over the years whereby the student is given a thorough insight into, or, if he is not a specialist, a good working knowledge of the several sciences which play the part of handmaiden to that vast, comprehensive whole—agriculture.

A knowledge of tropical soils—which are not always as good as the untravelled layman has been led to suppose—is, of course, fundamental. Soils make a whole universe. The problems of their formation, utilization, deterioration and regeneration under the many and varied types of climate and systems of cultivation found between Cancer and Capricorn, the methods of measuring their actual or potential fertility, and of studying the lives of the micro-organisms which inhabit them, are all made the subject not only of discourses in the lecture room, but also of demonstration and experimentation in the field and laboratory.

From the good earth spring the tropical crops—a grand and goodly host of them the variety and abundance of which far exceed the common knowledge of those who have never stirred beyond the confines of temperate lands. So, in his agricultural classes, and with the help of a living museum on the College Farm and in the island as a whole, the student becomes acquainted with the vast array of vegetable commodities that can be produced throughout the equatorial belt: rice, pulses, maize, among cereals; sugar cane, cotton, tobacco, cocoa, coffee, spices, rubber, bananas and exotic fruits innumerable, oil, fodder, and fibre crops, to mention only a few of the economic plants with which he may have to deal later in his career. But that is only part of the agricultural course. The study of livestock, its care and improvement in the tropics, the use of implemental tillage adapted to different needs and conditions, the methods of field experimentation, and many other aspects of knowledge and practice, all find their place in the curriculum.

As well as being marvellously and variously productive of the goods that man requires, Nature, in her infinite variety, has also at her command the forces of dissolution and decay. Diseases and pests emerge unheralded from the unknown to claim a heavy toll in the domain of agriculture. So in preparation for the maladies which will inevitably beset his crops wherever he goes, the student's education includes a survey of fungal diseases and insect pests and the methods by which they can be combated.

Faced with the large assemblage of tropical crops more or less completely new to him, the student, already a botanist, perforce must continue his botanical studies, not merely to familiarize himself with their structure, habitat and mode of life and the influence which different environments exert on their cropping power, but also to consider to what extent, by breeding and selection, new types, more productive, more disease-resistant and more adaptable to different environments can be obtained. Here it may be noted that the College course is so arranged that soil, agricultural, botanical and pathological studies, as well as field demonstrations, are carried out crop by crop in the closest conjunction.

Not last or least, there is instruction in the science of economics, for agriculture, as well as being an art and a science, is also a business. So is there a need for instruction in the methods of economics

as applied to agriculture in order that the true sources of wealth may be adequately understood, wasteful methods eliminated, and the financial and administrative fabric so adjusted as to make for increasing improvement, not only in the mere matter of pelf, but also in respect of the wider aspects, internal and external, of the social well-being of the community.

From this brief and rapid survey some impression may be gained of the wealth of new knowledge and experience that awaits the agricultural cadet. Nor is that all. He also receives instruction in veterinary science, and being himself an animal liable to the ills that beset the empire builder in torrid climes, is duly instructed in the niceties of tropical sanitation and hygiene.

So, at length, after a year that must seem all too short, the student stands forth, as yet inexperienced—a defect which time will rectify—but clad in the armour of knowledge, the torch of science in his hand, ready for service and determined "To strive, to seek, to find and not to yield."

Perhaps, if you travel the world and penetrate into strange and remote places, you may meet old College students. They are to be encountered everywhere throughout the Colonial Empire and Mandated Territories, in East and West Africa, Malaya, New Guinea, the Solomon Islands, British Guiana, the West Indies, Palestine, the Sudan; and they are doing splendid work. This aspect of British Imperial service must be the envy of the world. For while other countries may also possess fine colonies, none, without exception, can boast of such a service, unified by the fellowship that comes from the system of training and the fact that they have one and all studied in the same College. Indeed, the bonds that unite past students not only among themselves but also to their former professors at the College, has through the years created a system of correlated endeavour seldom to be encountered.

Diplomates

In its attempt to provide men for the agricultural services, official or commercial, the College casts a wide net. With the passage of time a diploma course has been evolved for the instruction of students of school-leaving age who are not proceeding to a university but who desire to qualify for a career in agriculture. These students receive a well-balanced training in the sciences pertaining to agriculture, in the many aspects of agriculture itself, and, if they wish to specialize in that subject, in sugar technology. For the latter purpose there is attached, to the College a model sugar factory, where a thorough training in all matters relevant to the production and preparation of that goodly commodity may be obtained. The members of the diploma course are derived principally from the West Indian islands and British Guiana; but they are also occasionally recruited from regions considerably more remote, while periodic accessions from the French West Indian Colonies and from the Latin American Republics provide a pleasing note of cosmopolitan variety to the College scene.

Diplomates may also play an important part in promoting the welfare of tropical agriculture. They are eligible for appointments in West Indian departments of agriculture, they do important work as sugar technologists, and are recruited as managers or advisers to some of the larger estates.

Library

The literature of agriculture, extensive and varied as its theme, cannot be adequately treated in a few words. But suffice it to say that in the College Library there has been assembled not only a comprehensive and representative collection of books, but also a wealth of information in the form of bulletins and memoirs, pamphlets and periodicals, from all parts of the world. Even in the world of letters modern conditions call for speed and efficiency; to meet this need the Library has been indexed and catalogued on a system whereby the information available on any subject can be immediately obtained.

The Scientific Way

If the way of the agriculturist is hard, he no longer stands alone. In the attempt to control the wayward forces of Nature, the resources of modern science are daily being applied on an increasingly extended front—a campaign in which the Imperial College plays its part, for by its constitution it is an institution for the promotion of research as well as for the propagation of knowledge. Because its functions are imperial, and its work intended to provide information for agricultural officers in their many spheres of activity, the major investigations undertaken fall into that category which may perhaps best be described as 'fundamental applied research'; but local problems are also tackled in collaboration with West Indian Departments of Agriculture.

Of necessity, the crops grown in the West Indies provide the raw material for investigation; but the problems selected for study are such as will tend to elucidate basic scientific principles rather than to yield results of immediate practical importance but of limited application. Not infrequently the research projects call for the collaboration of specialists in different fields. To illustrate a single instance of a College team in action and of the way in which investigators

throughout the Empire become linked together in a common cause, reference may be made to banana research. Some twelve years ago the heavy losses resulting from the rapid spread of Panama disease—a soil-borne disease of great severity widely distributed throughout the tropics and affecting the Gros Michel banana, the principal variety of commerce—gave rise to a scheme requiring the services of a pathologist to study the malady under field conditions, of a plant breeder whose task was to produce commercial hybrids resistant to the disease, and of a physiologist to investigate the cold storage and ripening behaviour of resistant varieties or hybrids which might be used as commercial substitutes for the Gros Michel. These three sub-divisions of the research programme were centralized at the Imperial College, and among other things led to the construction of plant quarantine houses and of a Low Temperature Research Station. But only part of the story has been told. To search for resistant varieties which might serve as substitutes for the Gros Michel and to provide materials from which desirable hybrids might be obtained, collectors from the Royal Botanic Gardens at Kew were sent to the East, the original home of the banana. In this unusual quest, which still continues, forestry and agricultural officers in remote places have taken a not inconsiderable part. Further, in order that diseases which have attained to epidemic proportions in the Orient might not be introduced into the West Indies, it was necessary to prepare a special quarantine house at Kew and one in Trinidad to provide the necessary safeguards. Meanwhile, in Trinidad, with the passage of time, new and promising hybrids have been raised and their carrying qualities tested, and a vast amount of useful information has been obtained and published on the botany of this important genus, the behaviour of different varieties and hybrids in storage, the basic physiological processes involved, and on the host of diseases which are liable to cause losses in the field and wastage during transport and ripening. By such a combination of effort it is evident that not only are present needs being served, but also a sure foundation of knowledge is being laid down for the future.

The fascinating story of banana investigations is only one illustration of the many research projects now receiving attention at the College. Reference might equally have been made to work on such crops as cacao, citrus, sugar cane; to storage investigations on exotic fruits; to soil surveys and kindred earthy topics; to economic probings into the workings of tropical industries and social systems; and to the many and varied problems of entomology and mycology. Lastly, it may be noted, a special point is made of introducing students to these manifold activities; as a result they go forth, not only with some knowledge of the methods by which problems may be tackled, but also with the feeling that they have, to some extent, become personally identified with researches whose value will become increasingly evident with the passage of time.

In a free world the fruits of knowledge should be available to all. This ideal pervades the work of the Imperial College of Tropical Agriculture. The results of all investigations are published in appropriate journals, and scholarly contacts are maintained with research workers throughout the world. Visitors are made welcome and given the fullest access to such information as they may require. So is the good name of the College being spread abroad, not merely as a scientific adjunct to local aspects of tropical agriculture, but also as a centre of teaching and research where sincerity of scholarship, integrity of purpose, and a realistic vision for the future, must inevitably play a profoundly important part in aiding humanity in a great practical need—to cultivate its tropical garden.

THE FOUNDATIONS OF EMPIRICAL KNOWLEDGE

By Prof. Herbert Dingle,
Imperial College of Science and Technology

FOR more reasons than one it is important that those who are engaged in acquiring empirical knowledge should sometimes ask what it is precisely that they are doing, and what is the significance of their work. Much depends on the answer to this question, for in the long run it determines the direction which history takes. High explosive and incendiary bombs may destroy the material products of civilization, but if civilization survives it can produce others: a false idea is a bomb of the delayed action type which may destroy civilization itself. For this reason I have on more than one occasion protested against the false notion, coming unfortunately from authoritative sources within the world of science itself, that what we call empirical knowledge can be acquired with-

out recourse to experience, and that future experience must conform to it.

This illusion is spreading, and philosophers are becoming its victims even more seriously than men of science. For whereas the scientific apostates substitute for experience the comparatively respectable goddess of reason, a vigorous and growing body of philosophers look to grammar as the source and essence of knowledge. Thus, R. Carnap, a leader among this group, maintains that what in science is usually called the ascertainment of an empirical fact by which a given hypothesis can be tested, is more properly described as the reduction, by formal conventional rules of syntax, of certain propositions, which constitute the hypothesis, to "observation-" or "protocol-sentences". These "observation-sentences", however, do not express the possible results of observation: the only criterion for determining their truth or falsity is the possibility of including them within the language used. But if the rules of the language make this impossible, we need not reject the hypothesis: "there always exists the possibility", Mr. A. J. Ayer quotes Carnap as saying, "of maintaining the hypothesis and renouncing acknowledgment of the protocol-sentences". Experience is eliminated altogether: knowledge consists of talking, and whatever you say is true if you do not contradict yourself.

In such a situation the appearance of a book on the foundations of empirical knowledge by a philosopher so acute and well informed in certain directions as Mr. Ayer*, is a matter of more than casual interest. It may be said at once that while Mr. Ayer has many affinities with the language school of philosophers, he does not share their determination to sidetrack observation: he believes that empirical knowledge originates only in experience, and that if you want to know whether the sentence "mercuric oxide is red" is true or not, you must look and see; it will not help you to study the rules of syntax. For this much must be forgiven him, and it may be that the service which he is thereby rendering to his day and generation is greater than he knows. Moreover, within the limits he sets for himself, he thinks with extreme clearness and expresses himself admirably. The book is a real pleasure to read. There is nothing here of the nebulous incomprehensibility which one often finds in philosophical works, and which one can only hope is a sign of profundity of thought. A sentence of Mr. Ayer's means one thing and one thing only, and you know what that thing is. Sentences are not repeated needlessly, and they succeed one another in perfect logical order. Apart from the rather annoying fact that the references in footnotes to other pages are usually wrong, there can be nothing but praise for Mr. Ayer's presentation of his case.

"My main purpose," Mr. Ayer writes, "has been to resolve the philosophical problems which are commonly brought under the heading of 'our knowledge of the external world'." The fundamental question which he considers is this: when (to use ordinary language) I "observe" a material thing, do I actually observe that thing, or something else (a "sense-datum") related thereto? The latter would appear to be what I really observe because when I look at a shilling, for example, from a certain angle and in a certain light, I see a yellow ellipse, while from another angle I see a black line; but the shilling itself is a white circular disk. A generalization of such facts as these leads some philosophers to say that what we observe are always sense-data, although in special cases the description of the sense-data may be identical with that of the material thing. Mr. Ayer, however, maintains that the question is a purely verbal one. I can always say I observe a material thing if I give to the phrase "material thing" the requisite meaning. In my example I can say that I observed the shilling on each occasion and that it was a yellow ellipse at first and changed to a black line later. It would be a curious way of speaking, but it would not lead us into contradiction.

The question "Do I observe material things or sense-data?" therefore cannot be decided by an appeal to experience as could such a question as "Do I see sovereigns or Bank of England notes?" Empirical facts can be described consistently whichever answer we give, and so the answer simply states what language we intend to use. If we appeal to facts, "it can be only to show that one form of expression is more convenient than the other". Mr. Ayer chooses the sense-datum language because, as he says, it is more convenient, and he proceeds to discuss how material objects can be "constructed" out of sense-data. Other questions also are dealt with, but this is the central one. What the thesis amounts to is this: the only condition a language has to satisfy is that its rules are free from self-contradiction, and between any two such languages the only ground for choice is convenience.

The first thought which all this arouses is that if our aim is merely to avoid contradiction, there is an admirable way of achieving it; namely, by saying nothing at all. This is also extremely convenient. We conclude, then, that philosophers should henceforth remain for ever silent. But Mr. Ayer would doubtless object that of course we want to describe something—that something being, as he admits, experience. But if that is so, then

* The Foundations of Empirical Knowledge. By Alfred J. Ayer. Pp. x+276. (London: Macmillan and Co., Ltd., 1940.) 10s. 6d. net.

surely there is another ground than convenience for choosing a language; we would prefer the one that enables us to say the most about experience. Here we see the grotesque inadequacy of Mr. Ayer's discussion to his professed subject. He has set out to discuss "the foundations of empirical knowledge"—"the philosophical problems which are commonly brought under the heading of 'our knowledge of the external world' "—without reference at all to the facts that during the last three hundred years there has been a philosophical movement (now called science, thus enabling philosophers to ignore it) which has enlarged the scope and deepened the significance of our knowledge of the external world to such an extent that the knowledge thereof obtained otherwise is by comparison negligible; and, second, that the condition which has made this possible is that men of science have progressively changed their language over and over again, invariably in order to be able to say more and more, and almost, if not quite, invariably from a more to a less convenient one. I will take two outstanding examples of this; but first let us see what kind of language science actually does use.

It is not the language of material things or that of sense-data as Mr. Ayer uses the term. It contains such words as "mass", "brightness", "shape", "motion", which represent groups of components of single sense-data. Jupiter is a material thing, but the mass of Jupiter is not a material thing. If Jupiter were to explode, the mass would continue undisturbed in its orbit at the centre of gravity of the fragments, while the material thing would be scattered in a million other places. The brightness of Jupiter is a function of something extending from the sun to the planet and then to the earth. The shape of Jupiter is a function of the number of times a metal bar at Paris would be contained in certain diameters if Jupiter were not moving with respect to it; and so on.

Each of these words can be ultimately expressed in terms of particular components of sense-data of Jupiter, but science is not in the least interested in putting the components together to make a sense-datum or in 'spelling out' Jupiter in terms of them. The mass of Jupiter is associated not with its brightness but with other masses, to give general laws of mechanics; and the brightness is associated not with the motion but with other luminosities, to give general laws of optics; and what science aspires to do ultimately is to subsume all such laws under a general correlation of all experience. The material thing, Jupiter, and the complete sense-datum of Jupiter, are alike without significance in this process, which, I repeat, has given us all but an infinitesimal fraction of our present knowledge of the external world. Yet Mr. Ayer's discussion of the "philosophical problems" relating to such knowledge makes no reference whatever to it, but concentrates on the manner in which material objects can be described in the language of sense-data.

The first example of changes of scientific language which I will take is probably the best known in the whole history of science—the languages used to describe motion. In the Ptolemaic system, motion meant "change of position with respect to the earth". Copernicus changed this to "change of position with respect to the sun". This was a most inconvenient change—so inconvenient that the ordinary man has never made it; he still speaks of sunrise. Even the astronomer makes it very rarely. In the greater part of his work he talks of the celestial sphere, of right ascension and declination, and so on; and the "Nautical Almanac", the indispensable handbook of applied astronomy, speaks practically without interruption in the Ptolemaic language (a fact which, it may be noted, is consistently overlooked by those who hold scientific progress to have been directed by social needs). But the change enabled the astronomer to say more when he wanted to do so. He could, for example, describe the variations of a planet's brightness in terms of the new language but not in terms of the old, and Newton showed him how he could speak of such diverse things as the movements of the moon and the fall of an apple in the same new tongue. Therefore, because of its greater scope, and in spite of its greater inconvenience, that tongue became the official tongue of science.

Time went on, and astronomers wanted to say still more, so Einstein made another change. He recommended that motion should no longer mean change of position with respect to the sun, but the slope of a world-line in a four-dimensional continuum. In that language you can say all that you said before, and more also. You can describe the motions of the planet Mercury, of light passing near the sun, and of the extra-galactic nebulæ. Is it a convenient language? Well, scarcely: it chokes you to speak it, but it allows you to 'say a mouthful'.

My second example shall be the scientific counterpart of one of Mr. Ayer's own—the only one for which I have space. In order to illustrate the equivalence (apart from convenience) of the languages of material things and sense-data, he instances the well-known fact "that a liquid will seem to have a different temperature according as the hand that is feeling it is itself hot or cold". In the language of sense-data, we have here two different sense-data associated with the same material object, and this contains no contradiction. If, however, we suppose that we are directly experiencing the same material thing with both hands, we appear to

obtain the contradictory result that the water is both hot and cold. But "to obtain the contradiction it must also be assumed that the temperature of the water with which the vessel is filled is really the same throughout", and this assumption may be supported by the fact that "it is observed to yield a uniform reading on a thermometer". The contradiction may therefore be avoided by asserting that the water was really hot in one part and cold in the other, and hence that thermometer readings, made with the precautions usual in science, give untrustworthy indications of temperature. This would be the account of the matter in the material object language, and, according to Mr. Ayer, it is equivalent to the account in the sense-datum language in everything but convenience.

Again one cannot help asking: What about the scope of the languages? If thermometers cannot be trusted, then the only describable thermal phenomena are our direct sensations of heat and cold. Here is a pretty science of heat! Presumably the fact that the thermometer reads higher in boiling salt solution than in boiling water is "knowledge of the external world", but since our bodies would detect no difference we cannot connect this fact with the difference that we feel between a winter's and a summer's day. The latter is a difference of temperature, but we must invent a new and independent language to express differences of thermometer readings.

What has science done with phenomena of this kind? It has begun by defining the temperature of a body as the equilibrium reading of a thermometer—a mercury thermometer, say—immersed in the body. The difference in the sensations felt by the two hands must then be explained by supposing that they had different temperatures when immersed, and this is consistent with all other relevant facts available. The definition is not so convenient as that of direct feeling, but it enables us to connect together—to "speak about"—a wider range of phenomena. But the range is still unduly limited for the physicist. He cannot measure the temperature of a bunsen flame or liquid air with a mercury thermometer, so he changes his language to one in which temperature means the reading of a 'perfect gas' thermometer. A perfect gas never changes its state, however hot or cold it gets, so that in the new language we can talk about the temperature of anything which the universe may contain. As for convenience, there is, it is true, a slight disadvantage in the fact that neither a perfect gas nor the only equivalent substitute—a reversible heat engine—can possibly exist, and we have to do the best we can with a real gas and make fairly elaborate corrections for its 'reality'. However, the physicist puts up with this, for he has only a pallid interest in convenience; it is the scope of his language that stirs his blood.

One would think that he had now gone far enough. But no; he soon becomes dissatisfied with the perfect gas thermometer and gives the word "temperature" a new meaning: it next stands for "the average kinetic energy of the molecules of a body". This is quite a new departure. In terms of this language he says that the temperature of interstellar matter is something greater than 1000° C., whereas he is quite confident that if a gas thermometer were placed in the matter it would read something near the absolute zero. Again the change is not made for convenience. If anyone thinks so, a page of Willard Gibbs will provide an infallible, though not a painless, corrective. The change is made solely because it enables us to speak of thermal and mechanical phenomena in the same language, and so enlarges our scope of expression.

So when Mr. Ayer tells us that a language which makes a thermometer reading an untrustworthy indication of temperature is equivalent in all but convenience to one in which a thermometer reading is trustworthy, the scientist must beg permission to dissent. It is true that, according to the latest definition, a thermometer no longer indicates temperature, but it is not untrustworthy, for we know why, and can predict when, it will fail. In interstellar space the matter is so rarefied that the thermometer receives impacts from the molecules very infrequently, and radiates away each increment of the acquired energy before the next arrives. To know this is to increase our knowledge, while to reject the thermometer in favour of direct bodily sensations is drastically to restrict it.

The immense and awe-inspiring knowledge of the external world which we now possess, and which continues to grow at an almost incredible rate, is indeed a matter of the deepest concern. What does it all mean? Is it a discovery of unalterable fact, or a creation which our reason can transform as experience grows? How comes it that by taking thought in a particular way, unknown to the ancients, we can add unlimited cubits to our stature and determine the course of the world's history? What exactly are we doing, and what are the potentialities of the ideas to which we are led, when we set reason to operate on experience in the manner which has yielded the bulk of the empirical knowledge which is ours to-day? The man of science, immersed in the process itself, rarely has the time or the aptitude to ponder these questions. He may realize their importance, but it is his chief function to produce the knowledge, not to assess it or discover its nature. For that we must look to the philosopher—to the man trained in the processes of accurate

logic and versed in the history of human thought. On the philosopher, in the modern sense of the word, rests a great responsibility, perhaps the most urgent responsibility in the world to-day—that of laying bare the foundations of empirical knowledge so that we may use it with foresight instead of a blind understanding. And when we turn to what one of the most able and promising of the younger philosophers has to tell us on this all-important question, we find that it is mainly a set of speculations on how to translate from one ineffective language into another. If Mr. Ayer were a less significant figure we might in silence leave his book to psychologists, for whom the question it discusses, and perhaps the discussion itself, has some academic interest. It is because of the possibility that he might yet bring his great talents to bear on the problem which he thinks he has already considered that his book deserves serious attention.

OBITUARIES

Prof. H. S. Hele-Shaw, F.R.S.

HENRY SELBY HELE-SHAW, who died on January 30 at the age of eighty-six, combined in an unusual degree the academic and the inventive mind. Educated privately, he served an apprenticeship for four years as a mechanical engineer, after which he won a Senior Whitworth Scholarship and with it proceeded to University College, Bristol. On completing the course, he was appointed lecturer in mathematics and engineering at Bristol, and a few years after, in 1881, was made professor of engineering. Four years later he was appointed the first professor of engineering at University College, Liverpool. He held this post until his resignation in 1904, when he was appointed first professor of engineering in the Transvaal Technical Institute; after a year he was made principal of the Institute. Soon afterwards the Secretary of State for the Colonies appointed him organizer of technical education in the Transvaal.

On returning from South Africa in 1906, Hele-Shaw set up a consulting practice in Westminster and carried this on with great success until his death. He was president of the Institution of Mechanical Engineers in 1922, and president in 1915 of Section G (Engineering) of the British Association. He delivered the James Watt Anniversary Lecture in 1902, the subject being "James Watt, Inventor". He was an LL.D. of St. Andrews, a D.Sc. of Bristol, and a D.Eng. of Liverpool.

While at Liverpool Hele-Shaw was largely responsible for collecting funds for the endowment of the chair of engineering and for the building of the Walker Engineering Laboratories. It was here, too, that he carried out his experimental work on streamline flow which established his reputation as a scientific investigator, and for which he was elected a fellow of the Royal Society in 1899.

It was during his early days at Liverpool that Hele-Shaw's inventive ability began to develop. He was much interested in the subject of friction and delivered four Cantor Lectures on the subject in 1886. It was about this time that he invented his well-known multiple-disk clutch. He also became very interested in road transport, and in 1897 organized the Liverpool trials of commercial vehicles for the Liverpool Automobile Club and Self-Propelled Traffic Association. He became president of the Institution of Automobile Engineers in 1909.

After taking up consulting practice, Hele-Shaw developed several important inventions, among which his hydraulic variable-speed gear, the streamline filter, and the Victaulic pipe joint are especially worthy of mention. His most recent important work was on variable-pitch airscrews.

As an organizer of technical education Hele-Shaw did valuable work, especially in more recent years in connexion with the introduction of National Certificates. In 1920, when the Board of Education approached the Institution of Mechanical Engineers with a view to collaboration in a certificate scheme to take the place of the old Science and Art Certificates, Hele-Shaw was chairman of the Education Committee of the Council, and it was largely due to him that the scheme was adopted. He was the first chairman of the Joint Committee and held this post until 1937.

Until the end he was a remarkably vital character. As a lecturer he was breezy, humorous, and unconventional, and as such will be happily remembered by more than one generation of students.

A. H. GIBSON.

Sir Pendrill Varrier-Jones

BY the tragically sudden death on January 30 of Sir Pendrill Varrier-Jones in his fifty-eighth year the medical profession has lost a pioneer in the full tide of his activities. The only son of Dr. C. Morgan Jones of Glamorgan, he was educated at Epsom College and St. John's College, Cambridge, where he was a foundation scholar and prizeman, graduating in the first class of the Natural Sciences Tripos, Part 1. Proceeding to St. Bartholomew's Hospital he qualified there and became house physician. On the completion of his term of office he returned to Cambridge for pathological research under Sir German Sims Woodhead. At the outbreak of the War of 1914-18 the Cambridgeshire tuberculosis officer joined the R.A.M.C., and Varrier-Jones, who was graded as unfit for military service, was asked to undertake his work temporarily. He accepted with some reluctance, for hitherto his interests had been directed purely to laboratory research.

It is difficult to realize to-day the total inadequacy of the treatment of pulmonary tuberculosis fifty years ago. Too often the out-patient at hospitals merely received some cod liver oil and cough mixture, after waiting for some hours at the risk of infecting other patients. Open-air sanatoria, both in Norfolk, were started in the middle 'nineties by Dr. Jane Walker and by Dr. Burton-Fanning. Then King Edward VII by his question "If preventible why not prevented?" galvanized the authorities into some sort of activity, resulting in the establishment of the sanatorium at Midhurst. Though interest in the subject had now been aroused, no large-scale plans were made until the National Health Insurance Act, with the consequent provision of hospital and dispensary facilities.

The point on which Varrier-Jones seized was the great liability of the patient to relapse on his return to the environment in which he had contracted the disease, thus nullifying the efforts that had been made. Engaging the support of Clifford Allbutt, Sims Woodhead and Humphry Rolleston, he started a village settlement at Bourn in Cambridgeshire in 1915 with only one patient in a shelter, but filled with a vision of the future. That vision was for the patient to pass through all the stages of hospital and sanatorium treatment, and to be provided with occupation suited to his state of health. When afebrile he was to work at a trade for the trades union rate of wages. He would reside in a hostel, or if married, in the village settlement with his wife and family. If at any time his health relapsed he would be sure of prompt and expert treatment in the institution. And Varrier-Jones lived to see that audacious vision realized. In 1918 much more extensive premises were obtained at Papworth Hall, and gradually the institution expanded over five hundred acres of land, complete with administrative blocks, hospital wards, a large sanatorium, laboratories and a research institute, a village settlement of more than a hundred cottages, hostels for men and women, and factories with annual sales which together with those of Enham, have now reached nearly half a million pounds annually. This might have been considered sufficient for the activities of any man, but they were not enough for Varrier-Jones. He was honorary medical director of the Enham Village Centre for ex-Service men, replanned the Preston Hall Village Settlement at the request of the British Legion, and advised on the establishment of a village settlement near Dublin. His latest ambition was to add a teaching department to Papworth, and he was writing enthusiastically to some medical supporters about this only an hour before his death.

Enthusiasm was indeed the keynote of his character, reinforced by tenacity and tireless energy. He has been well described as a Celt with all the Celt's fire and imagination and with the long black hair and gestures of an impresario. In early life he was nicknamed the Pendragon, and he adopted this as the trade-mark of the Papworth goods. Sir Clifford Allbutt said of him that he restored hope to those who had lost it, and there is no doubt that his great success was due to the force of his personality. So individual were his gifts that it is difficult to see who can succeed him, for clinical insight and great business capacity are seldom united. Yet there can be no doubt that his plan is capable of wide extension and would greatly help to solve the problem of pulmonary tuberculosis, converting damaged lives from a liability to an asset for the community. He was strongly of opinion that the community by insisting on the notification of tuberculosis thereby accepted responsibility for those on whom it had imposed this handicap. It was his proud boast that no child born in the settlement of a tuberculous parent had ever developed tuberculosis.

The value of his work was publicly recognized by a knighthood in 1931, the fellowship of the Royal College of Physicians in 1934, and the Weber-Parkes Prize in 1939. W. LANGDON-BROWN.

Prof. V. Putti

PROF. VITTORIO PUTTI, the eminent orthopædic surgeon, who died recently, was born on March 1, 1880, at Bologna, where he received his medical education and qualified in 1903. For eleven years he was assistant to Alessandro Codivilla at the Rissoli Institute at Bologna, of which he became director in 1914. In 1909 he was appointed lecturer in orthopædics and in 1914 professor in this subject at his Alma Mater. In 1917 he founded the journal *Chirurgia degli Organi di Movimento*, to which *Bibliografia Ortopedica*, founded by him three years later, containing summaries of current orthopædic literature, formed a useful supplement. Putti introduced many new orthopædic operations and made numerous valuable contributions to the literature of his speciality, particularly on congenital dislocation of the hip, osteoarticular tuberculosis, for the electrotherapeutic treatment of which he founded the Codivilla Institute at Cortone d'Ampesso as a branch of the Rizzoli Institute, diseases of the vertebral column, transplantation of muscles and Madelung's deformity. Enjoying an international reputation, he received invitations to lecture in several foreign countries including Great Britain, where he had many friends. J. D. ROLLESTON.

WE regret to announce the following deaths:

Dr. Rendel Harris, F.B.A., the well-known biblical scholar, archæologist and Orientalist, on March 1, aged eighty-eight.

Prof. C. R. Lanman, professor of Sanskrit at Harvard University during 1880–1937, and a corresponding member of the British Academy, who was a distinguished Orientalist and authority on ancient Indian languages and literature, aged ninety.

Mr. C. A. Ludwig, associate plant physiologist in the Division of Soil Microbiology of the Bureau of Plant Industry, U.S. Department of Agriculture, on January 7, aged fifty-four.

Dr. Adolpho Lutz, for many years chief of the department of medical zoology at the Institute Oswaldo Cruz, Rio de Janeiro, aged eighty-four.

Dr. C. B. Ticehurst, the distinguished ornithologist and editor of *Ibis*, on February 17, aged sixty.

NEWS AND VIEWS

Mineral Nutrition of Plants

THE 1,000 dollar prize of the American Association for the Advancement of Science has been awarded to Dr. D. I. Arnon of the University of California for a paper read at the Philadelphia meeting of the Association on behalf of a seven-man laboratory team under the guidance of Prof. D. R. Hoagland. Since Prof. Hoagland's first experiments upon the mineral economy of Nitella—where it was shown that the growing cell swept most of the ions out of the surrounding medium, piling them up within its own sap, although thus doing work in accumulating them against the concentration gradient, whilst the mature or senescent cell indicates its advancing age by an inability even to retain or maintain this internal solute concentration—the workers in Prof. Hoagland's laboratory have rapidly established quite a new conception of the mineral nutrition of the higher plant. This has thrown a new light upon the high concentration of mineral ash in growing tissues and has thus made clear to agriculturist, and still more to horticultural and forest botanist, what large reserves of minerals may be available in adult regions of the plant, to be utilized over again after release and transfer from adult to growing regions.

Prominent in this work has been Dr. F. C. Steward, working first at the University of Leeds and later at Birkbeck College, London. In some of this work a technique has been employed with great success of introducing a new ion, bromine, and following the conditions governing its absorption and distribution. Dr. Steward has also shown, by his studies at the Tortugas, that the students of the salt accumulation of the large cells of Valonia cannot afford to neglect consideration of its growth phases or of the conditions under which it is maintained during the period of the experiment. He has also advanced our general knowledge of salt accumulation by his utilization of spectrometer methods which permit a rapid quantitative control of the rates of ionic interchange. Dr. Arnon himself has contributed particularly to our knowledge of the conditions governing the relative utilization of ammonium and nitrate sources of nitrogen; he has also been associated with a series of investigations upon the significance of relatively rare elements in plant nutrition, such as copper, zinc, manganese and molybdenum. Altogether, the work recognized by the American Association in this award represents a contribution which stands very high in the esteem of plant physiologists and in which the English contribution, associated with Dr. Steward and his collaborators, reaches the same high standard, both of experimental technique and critical interpretation.

Abyssinian Ornithology

THE invasion of Abyssinia and Somaliland has given members of the British army who are ornithologically minded a unique opportunity for observation in an area little explored by naturalists, and the outcome may prove as useful as the information noted by ornithologists stationed in Egypt in the War of 1914–18. Cheesman (*Ibis*, 1935) made a detailed survey of bird life in north-west Abyssinia, where he collected for the British Museum when H.M. Consul. The Abyssinian flappet lark, producing a rattle-like wing-sound when rising in song, is resident on the high plateau, the white-collared pugin, the great hammerkop and the African barn-owl nested at the British Legation at Addis Ababa. At Lake Tana there are black crakes, paaw bustards, egrets, buff-backed herons, a colony of white-bellied storks, spur winged geese, tufted duck, pochard, white-eyed duck, sea eagles, ospreys, marsh-harriers and lesser black-backed gulls. Wheatears are frequent passage migrants on the big grass plains, and these include the eastern black-eared wheatear.

The avifauna of the region includes many of its own forms as well as European birds on migration and rarer British species like the wood sandpiper and gull-billed tern, but there remains an enormous scope for field studies of bird habits in addition to compiling lists and skins. Cheesman obtained a new race of Cisticola or striped grass warblers at Wanbera, not previously visited by ornithologists, comprising a dozen species. Bird life is probably richest near the waters, like the Blue Nile and Lake Tana, with a wealth of waders, duck and fishing birds, but the colony of red-legged choughs at Simen is of considerable scientific interest, for the nearest colony to this is apparently at Cyprus. The Ethiopeans have never been greatly interested in their fauna, and although the chief dangers to bird life are the big fires, the protection of the larger insectivorous birds would no doubt help their agriculture against the locust and other pests.

Earthquake in Greece

ABOUT 5.55 a.m. local time on March 1, a severe earthquake shook many towns and villages in northern Greece. At Larissa, in Thessaly province, houses were destroyed, telephone and telegraph and other buildings damaged and some streets blocked by debris. Many people were frightened and left their houses. One person has been reported killed and five injured. Extensive damage was caused at Elassona, and the epicentre may have been near this place. The shock was also felt at Volo and Lamia, Kanditsa and Trikkala. In the whole district there may be as many as 15,000 people homeless as a result of the earthquake, although complete details are not available at the time of writing. Rescue work is being undertaken by the local authorities and by British soldiers and airmen.

The earthquake follows fairly recent earthquakes in Rumania and Cyprus. The epicentres of Greek earthquakes appear to bear some relation to the great lines of fracture to which the country owes its

outline. Earthquakes are particularly frequent around the narrow gulf which separates the Peloponnesus from the mainland, and in the peninsula of Messene in south-western Greece, but in the past they seem to have been less frequent in the area now affected. It will be remembered that severe earthquakes took place in Greece on July 21, 1938, near Oropos, when about seventeen people were killed and eighty injured, and on April 17, 1940, near Patras, and Missolonghi, though on this latter occasion no casualties were reported.

Leadership

THE Lees Knowles Lectures on "Generals and Generalship" delivered at Trinity College, Cambridge, in 1939, by General Sir Archibald Wavell and recently published in *The Times*, have now been reprinted and published as a pamphlet, with a foreword by General Sir John Dill (Times Publishing Co., Ltd., Printing House Square, London, E.C.4. 6*d*.). Dealing essentially with the principles of leadership and the relations of man to man, they have an interest that extends far beyond military circles. Sir Archibald Wavell takes a quotation from Socrates as giving the best definition of the essential qualities of a commander, and agrees with him in placing administration first, while tactics or the handling of troops in battle comes last. Character, or knowing what he wants, with the courage and determination to get it, and a genuine interest in, and knowledge of, humanity come first in the moral qualities of a leader, while in the mental qualities, commonsense, or the knowledge of what is and what is not possible is the most important. The bearing of this analysis on problems of technical administration generally will be readily perceived, and Sir Archibald's remarks on the commander and his troops are equally suggestive and stimulating. There are many in industry who might well apply Sir Archibald's simple rules that a general should never try to do his own staff work, and that he should never let his staff get between him and his troops. Tradition and discipline, he holds, are the root of the matter in relations between the general and his men.

The third lecture, in which General Wavell deals with the relations of higher commanders with the statesmen who direct them, is in some ways the most significant in its suggestions for removing the friction between civil and military which tends to be a feature of democracy in war. Making the point that knowledge of the mechanics of war, not of the principles of strategy, distinguishes a good leader from a bad, and that both war and politics have been too highly specialized to be interchangeable professionally, Sir Archibald urges that a better understanding between the commander and the politician is essential for the conduct of modern war. The qualities which lead to excellence in generalship or in statesmanship have indeed much in common and should promote the thoughtful study of the past, the receptive mind and the patient understanding of each other's difficulties which are the key to mutual knowledge and understanding. General Wavell's lectures, which show all the lucidity of exposition and thought already apparent in his life of Lord Allenby, should do much to promote such understanding in all classes of our society, and enhance the confidence which we place in our present-day commanders.

Function of Treaties

MR. A. D. MCNAIR'S admirable pamphlet "War and Treaties" (Oxford Pamphlets on World Affairs, No. 32. Oxford: Clarendon Press. 3*d*. net) makes a most pertinent contribution to discussions on the new world order to be established after the War. In the poverty of international legal institutions, a treaty has to serve too many purposes, and this has largely contributed to the recent shocks to the sanctity of treaties and the shattering blows to the mutual good faith which lies at the very basis of our society. No principle of law has received such universal homage and is so widely spread as the rule *pacta sunt servanda*—agreements must be kept. Moreover, while a treaty can be violated not only by a clear breach or an unjustified denunciation but also by the much subtler means of a claim by a party to a treaty to be entitled to give it his own interpretation, once Governments have been led to refer a dispute concerning interpretation to an international tribunal, it is most rare for them not to carry out the decision. While the sanctity of treaties is a fundamental principle of international relations if force is to be excluded, treaties must contain within themselves the machinery for the revision of their provisions, or such machinery must be created outside them and be applicable to them. The problem of reconciling stability with means of peaceful change, of finding a mean between rigidity and flexibility, has, however, so far baffled international society and has been responsible for one crisis after another.

It is futile, Mr. McNair urges, to attempt to superannuate war unless we can substitute some peaceful machinery for achieving one of the common objects of war—changes in the *status quo ante*. That peaceful machinery, if it is to amount to more than revision by consent, must involve a willingness to accept the judgment of some kind of international tribunal or authority upon the equity of a claim, instead of insisting on being judge in one's own cause. Moreover, before the 'Family of Nations' can become a true society, some control must be placed upon the present licence in treaty-making. In view of the far-reaching danger to society which is implicit in a bad treaty, society must sooner or later acquire some kind of initial control upon treaty-making. Many treaties are more than the concern only of the contracting parties. The lack of any machinery for the supervision of treaty-making, and the paucity of rules upon the legality of treaties, are a serious defect in our present system. Commenting on the progress of the International Labour Organisation, Dr. McNair suggests that introduction of its practice of using non-governmental delegates, with the resultant encouragement of a more co-operative atmosphere, into a wide

field of international affairs should make an important contribution to the development of a real international society by assisting the removal from international law of some of these imperfections and immaturities in regard to treaties.

Further Amendments to the Pharmacopœia

FURTHER amendments, due to conditions arising out of the prosecution of the War, have been made to the "British Pharmacopœia". They have been made effective by notices in the *Gazettes*. Owing to the closing of the principal source of supply of squill, namely Sicily, sanction is now given for the use of Indian squill (*Urcinea indica*) in place of *Urcinea scilla* in the preparation of oxymel, vinegar and tincture of squill. In the case of valerian, which was formerly obtained chiefly from Belgium, Holland and Germany, the use is now permitted of Indian valerian (*Valeriana wallichii*) in place of *Valeriana officinalis* whenever valerian is prescribed or demanded. Another amendment sanctions the use of sodium lactate instead of glycerin in the preparation of poultice of kaolin, the object being to assist in the conservation of supplies of glycerin. Facilities have been given by the appropriate Government departments for the importation of Indian squill and Indian valerian.

Institute of Chemistry

AT the annual general meeting of the Institute of Chemistry held on March 3, the president, Dr. J. J. Fox, C.B., the Government Chemist, presented the report of the Council, in the course of which he stated that the professional examinations of the Institute had continued, and the membership had increased by more than 220 during the year. The increase in the numerical strength of the Institute since 1914, he said, has been remarkable; it has been multiplied more than five times, namely, from 1,454 to 7,775. In the meantime, unemployment among the members has never exceeded 3 per cent and at the present time is less than 1 per cent. Industry was far more fully staffed with chemists in September 1939 than in July 1914, but the Institute had been of much assistance to the Government in supplying chemical personnel during the War. Dr. J. J. Fox was re-elected president; and the Meldola Medal for 1940 was awarded to Dr. E. R. H. Jones, assistant lecturer in organic chemistry in the Imperial College of Science and Technology.

Food in War-time

An important article, "Food in War Time", by Lord Horder in the *Quarterly Review* of January emphasizes the way in which food policy in war could be utilized to make a permanent contribution to national fitness, and the part which science has to play in pursuing this objective. Science, Lord Horder points out, supports a return to the diet that kept our fathers and forefathers fit, and assures us that in doing so we are on sound and rational lines. The memorial sent to the Prime Minister last May, of which Lord Horder was a signatory, urged that milk, potatoes, fresh vegetables, cereals, fats and sugar, should be kept constantly in mind as the basis of fitness. The whole consumption of the first three could be grown at home, and better use of our home-grown fruit would enable us to reduce considerably our imports of fruit. We could grow all the oats we need and much more of the wheat and barley.

A comprehensive food policy connotes close and constant co-operation between the Ministries of Food, Agriculture and Transport; intelligent co-operation on the part of the consumer is essential to success in a campaign for feeding the people properly in war-time, and Lord Horder pleads for greater use of the educational opportunities given by war-time conditions. By planning wisely we could rapidly enable the town worker to retrace his steps in the matter of diet, making more accessible the wholesome foods which his ancestors ate and which he discarded when he became urbanized, and at the same time making less available the more unsuitable foods which have taken their place for the last two generations. In such planning the Minister of Food has the guidance and backing of science and medicine, and this contribution to building a better social and economic system could start now.

Merseyside Naturalists' Association

AT the third annual meeting of the Merseyside Naturalists' Association, held at the Liverpool Museum on February 23, Mr. R. K. Perry, keeper of vertebrates at the Museum, was elected president, Dr. J. C. P. Miller of the University of Liverpool, chairman, and Mr. Eric Hardy, honorary secretary. Since 1939 membership and funds have doubled, activities have been continued in full, with a well-attended programme of meetings; additions to the local flora have been made to the national herbaria at Kew and the British Museum. The president exhibited a collection of skins of rare British mammals, detailed reports were presented of bird surveys at Leigh Flashes, Rufford, Puffin Island, the Great Orme's Head, Corwen, etc., and the MS. of the Association's proposed handbook on the birds of the area. As this is by far the largest natural history society in the area it was agreed to continue activities so far as the War permitted.

American Geographical Society: Medal Awards

Two medals have recently been awarded by the American Geographical Society. Dr. R. C. Murphy, of the American Museum of Natural History, receives the Cullum Geographical Medal for distinguished work on the migration and habits of oceanic birds, which are his speciality. He is the first ornithologist to receive this medal, which has previously been awarded thirty-five times. Earlier recipients have included Admiral Robert E. Peary, Sir John Murray and Prince Albert of Monaco. Prof. C. O. Sauer, of the University of California, receives the Charles P. Daly Medal, in recognition of his outstanding contributions to geography, especially in the fields of land classification and land utilization. Among the twenty-nine recipients of the Daly Medal have been Vilhjalmur Stefansson, Capt. Robert A. Bartlett and Dr. Roy Chapman Andrews.

Institution of Mechanical Engineers: Awards

THE following awards have recently been made by the Institution of Mechanical Engineers: *Thomas Hawksley Gold Medal* to Dr. F. D. Smith and bronze replicas of the Medal to his co-authors, E. H. Lakey, H. Morgan, and C. A. Luxford, for the following papers which were presented as a group: "The Admiralty Cathode Ray Oscillograph Engine Indicator" by F. D. Smith, E. H. Lakey and H. Morgan; "Basic Principles in the Design of Cathode Ray Oscillograph Engine Indicators" by F. D. Smith; "Stress Measurement by Magnetostriction" by F. D. Smith and C. A. Luxford. *George Stephenson Prize* to Dr. R. C. Plumb and Prof. A. C. G. Egerton, for their paper on "A Criterion for Knock in Petrol Engines". *Dugald Clerk Prize* to G. W. A. Green for his paper on "Fuel Injection in Oil Engines in Relation to Combustion". *Water Arbitration Prize* to Dr. E. G. Holley for his paper on "The Static and Fatigue Torsion Strengths of Various Steels with Circular, Square, and Rectangular Sections". *Starley Premium* to Prof. W. T. David and Dr. A. S. Leah for their paper on "Fuel Economy in Petrol Engines". *Herbert Akroyd Stuart Prize* to Dr. G. F. Mucklow for his paper on "Exhaust-Pipe Effects in a Single-Cylinder Four-Stroke Engine", and R. W. Zdanowich and T. S. Wilson for their paper on "The Elements of Pendulum Dampers". *Thomas Lowe Gray Prize* to Prof. W. Kerr, Dr. J. F. Shannon and Dr. R. N. Arnold for their paper on "The Problems of the Singing Propeller". *T. Bernard Hall Prize* to F. Dollin for his paper on "Investigation of Steam Turbine Nozzle and Blading Efficiency".

An Active Sunspot

AFTER several weeks of generally diminished sunspot activity, a large sunspot developed rapidly on the sun's disk between February 26 and 28. The spot was apparently associated with marked chromospheric activity on the latter date. The time of central meridian passage of the disturbed area was February 27·3.

Royal Society of Edinburgh: New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr. H. A. Cookson, Sunderland Royal Infirmary; Dr. C. A. Coulson, Mathematics Department, University College, Dundee; Mr. Atulananda Das, Imperial Forest Service, Shillong, Assam; Dr. J. N. Davidson, Biochemistry Department, University of Aberdeen; Prof. E. C. Dodds, Courtauld Institute of Biochemistry, Middlesex Hospital, London; Dr. E. Finlay-Freundlich, Department of Astronomy, University of St. Andrews; Mr. A. G. L. Gerard, assistant superintendent, Tongland Power Station, Kirkcudbright; Mr. J. C. Gibson, assistant secretary, Air Ministry, London; Mr. James Gray, 7 Spence Street, Edinburgh; Mr. R. L. Gwilt, secretary, Scottish Widows' Fund, Edinburgh; Mr. James Jamieson, engineer and manager, Edinburgh Corporation Gas Department; Prof. Mangalore Kini, Medical College, Andhra University, Vizagapatam; Mr. A. C. Marshall, director of education, County of Clackmannan, Alloa; Dr. A. G. Mearns, Department of Hygiene, University of Glasgow; The Hon Lord Moncrieff, senator of the College of Justice in Scotland, Edinburgh; The Hon. Lord Murray, chairman of the Scottish Land Court, Edinburgh; Dr. Ivan Parnell, Institute of Helminthology, Macdonald College, Quebec; Dr. E. G. V. Percival, Department of Chemistry, University of Edinburgh; Dr. F. E. Reynolds, pathologist to the Municipal Hospital, Glasgow; Mr. J. J. Robertson, rector, Royal High School, Edinburgh; Dr. A. D. Ross, Department of Civil and Mechanical Engineering, University of London; Dr. H. Scarborough, Department of Therapeutics, University of Edinburgh; Mr. A. Steuart, lately president, Royal Scottish Society of Arts, Edinburgh; Dr. R. L. Sutton, assistant professor of dermatology, Kansas Medical School, Kansas City, Missouri, U.S.A.; Dr. George Trapp, biology master, George Watson's Boys' College, Edinburgh; Dr. D. A. Walker, teacher of science, Daniel Stewart's College, Edinburgh; Mr. J. E. Wilson, senior research officer, Ministry of Agriculture and Fisheries, Edinburgh.

Announcements

PROF. JAMES B. CONANT, the distinguished organic chemist and president of Harvard University, who is a member of the U.S. National Defense Research Committee, is visiting Great Britain to confer upon collaboration in the scientific field.

DR. L. J. SPENCER, formerly keeper of minerals in the British Museum (Natural History) has been awarded the Roebling Medal of the Mineralogical Society of America.

THE Swammerdam Medal for 1940 has been awarded to Prof. G. W. Grijne of Amsterdam, the Nestor of Dutch physiologists. The six previous recipients have been K. T. E. von Siebold (1880), Ernst Haeckel (1890), K. Gegenbaur and Hugo de Vries (1910), Max Weber (1920) and H. Spemann (1930).

ACCORDING to a wireless dispatch to the *New York Times*, Prof. Paul Langevin, formerly professor of experimental physics in the Collège de France, who had been detained in prison in Paris, has been released on parole for reasons of health. Prof. Langevin was deprived of his professorship because of his political activities.

THE Ministry of Agriculture is anxious to give every possible help to gardeners and allotment holders in the "Dig for Victory" campaign. The season for planting is just beginning, and it is of the first importance that the right crops be grown so as to avoid the production of surplus perishable summer vegetables. Plans made now mean plans for next winter, and adequate space must be allocated to the growing of the valuable potato, onion, carrot, beetroot and other crops that can be stored, and used as substitutes for foodstuffs that are normally imported. A suitable lay-out and cropping plan is given in Growmore Leaflet No. 1, which can be obtained free from most local authorities, while for more specialized information attention may be directed to Leaflets No. 32 on seed potatoes and No. 57 entitled "Tomato Growing is not Difficult".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Linkage between the Repeating Units in the Starch Molecule

IN an earlier paper[1] we presented evidence which indicated that the starch molecule is made up of a large number of repeating units (each consisting of an unbranched chain of some thirty glucose units) combined together in such a way that the free reducing group of one unit is linked glucosidically with a hydroxyl group of the adjacent unit. It is now apparent that in the derivatives of starch we have examined, the hydroxyl group concerned in the glucosidic union of the repeating units, is a primary alcoholic group situated at C_6 of one of the glucose residues. The occurrence of this mode of linkage was indicated previously[2] and was suggested simultaneously by Freudenberg and Boppel[3]. In this connexion it may be mentioned that we have never advocated the views on the structure of starch recently attributed to us by Kurt Meyer[4], and that, on the other hand, if each of the units represented in the formula suggested by Meyer is considered to contain some thirty glucose residues, his formula becomes identical in type with the structure we have advocated[1].

The new results are derived from the following experiments. Methylated rice starch was disaggregated[1], giving material of low molecular weight, specially suitable for experiments on the mode of linkage in that it readily undergoes complete methylation. On hydrolysis, the fully methylated derivative gives rise to 2 : 3 : 6-trimethyl glucose, 2 : 3 : 4 : 6-tetramethyl glucose (end-group) and dimethyl glucose. It is evident that one of the two free hydroxyl groups of the dimethyl glucose represents the point of junction of the repeating units. Examination of the dimethyl sugar has revealed that it consists almost entirely of 2 : 3-dimethyl glucose, from which it follows (since C_4 is involved in the linkages of the glucose residues within the unit) that the repeating units are connected through C_6 of one of the glucose residues. The yield of dimethyl glucose (3 per cent) is consistent with the view that one such linkage exists per repeating unit. The exact position of the particular glucose residue in the chain of the repeating unit is not yet known and the problem of its determination is of special importance in connexion with enzymic degradation of starch[5]. It is to be observed also that the present evidence concerns the linkages in the disaggregated derivative, and the further question, whether all the linkages connecting repeating units in the original starch are of similar type, must await further investigation.

The following evidence served to identify the 2 : 3-dimethyl glucose. (*a*) It forms both furanose and pyranose methyl glycosides, since in cold methyl alcoholic hydrogen chloride the rotation drops from $[\alpha]_D + 59°$ to $-30°$, and in boiling methyl alcoholic hydrogen chloride it rises to $+75°$. (*b*) The amide of the corresponding dimethyl gluconic acid gives a negative Weerman reaction with sodium hypochlorite. The hydroxyl at C_3 is therefore methylated. (*c*) The *p*-toluene sulphonyl derivative of the dimethyl methyl glucoside, when heated with sodium iodide in acetone at 100°, gave sodium *p*-toluene sulphonate (yield 87 per cent of the theoretical), and this was corroborated by an estimation of the iodine content of the syrup isolated after removal of the sodium *p*-toluene sulphonate. C_6 therefore carries a free hydroxyl group[6] and this, in conjunction with the other evidence, fixes the constitution as 2 : 3-dimethyl glucose.

The quantitative aspect of these results shows that other dimethyl glucoses cannot have been present in more than minute amounts, insufficient to affect the conclusions outlined above.

C. C. BARKER.
E. L. HIRST.
G. T. YOUNG.

The University,
Bristol.
Feb. 10.

[1] Hirst and Young, *J. Chem. Soc.*, 1471 (1939).
[2] Bawn, Hirst and Young, Faraday Society Discussion, May 1940; *Trans. Faraday Soc.*, **36**, 881 (1940).
[3] *Naturwiss.*, **28**, 264 (1940).
[4] Meyer, K., *Helv. chim. Acta*, **23**, 880 (1940).
[5] Hanes, *New Phyt.*, **36**, 538 (1937).
[6] Method of Oldham and Rutherford for estimation of primary alcoholic group in sugars. *J. Amer. Chem. Soc.*, **54**, 366 (1932).

A New Method of obtaining the *N* Pattern of Electron Diffraction

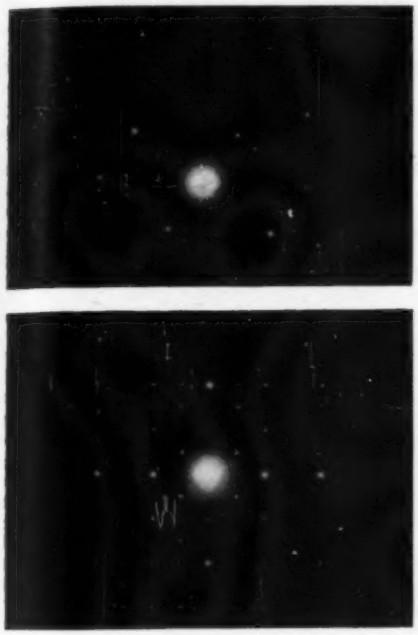
THE *N* pattern of electron diffraction was first obtained from a thin piece of mica. It has not been obtained for many substances because of the technical difficulty of preparing single crystal films of suitable thickness for electron penetration.

I have discovered a method of preparing two-dimensional films of various substances, and a big field of investigation by electron diffraction is now opened.

The *N* patterns shown in the accompanying photographs were obtained by the new method of preparation; the films, which may properly be called synthetic, are laboratory products and are made by allowing chemical reactions to take place under physical control.

Thin films of water or hydrochloric acid were first prepared by immersing a platinum wire gauze in water or in the acid (12 *N*) and then withdrawing it. Upon bringing such films into contact with a clean piece of potassium or calcium, chemical reaction

immediately takes place, giving films of the reaction products adhering to the gauze and highly suitable for transmission electron diffraction experiments. The upper pattern is from a potassium bicarbonate ($KHCO_3$) single crystal produced by the method



described, the reaction being allowed to take place between potassium and water in the presence of air; the lower pattern is from a calcium chloride ($CaCl_2 \cdot 2H_2O$) single crystal similarly obtained but utilizing the reaction between calcium and 12 *N* hydrochloric acid.

The potassium bicarbonate crystal has already been studied by X-rays and the data serve well for comparison here. The dimensions of the reciprocal lattice determined by the *N* pattern here obtained are: $a^* = 15{\cdot}4$ A. and $b^* = 5{\cdot}72$ A.; X-ray work gives $a = 15{\cdot}01$ A., $b = 5{\cdot}69$ A., and $\beta = 104° 30'$ (monoclinic structure). The new method of preparing films thus gives results in good agreement with X-ray findings.

As is well known, structure determination from the *N* pattern is more definite than that by X-rays, hence the present work is in this respect also of significance. Due to the highly hygroscopic nature of $CaCl_2 \cdot 2H_2O$, the determination of its structure has been beyond the scope of X-ray technique. I am working on its structure as given by the *N* pattern here obtained.

This work has been conducted under the direction of Dr. Ichirô Iitaka.

SHIGETO YAMAGUCHI.

Institute of Physical and Chemical Research, Tokyo.

REFERENCES.

Kikuchi, S., *Jap. J. Phys.*, **5**, 83 (1928); Nishikawa and Kikuchi, NATURE, **121**, 1019 (1928).
Dhar, J., *Indian J. Phys.*, **11**, 187 (1937).

Magnetization of Matter by Light

ONE of us (F. E.) has shown that small particles of matter of different chemical elements, but of the same physical qualities, irradiated by concentrated light, move in a homogeneous magnetic field, some of them toward the north, some toward the south pole (magnetrode). Therefore, there must be a preponderance of either north or south magnetism on each of those irradiated particles, and they behave like single magnetic poles (charges)[1]. Further, experiment led to the conclusion[2] that, in addition to the oscillating electric and magnetic vectors, light beams must have electric stationary components in the direction of the wave front normal, and that consequently there must be stationary electric potential differences between different points along the beam; and that there must be also a stationary magnetic field in the beam of light with potential differences. Hence, the light beam must have a magnetizing effect, and the charge of a magnet should be changed by light.

Examination of the literature by the other of us (L. B.) showed that even before the time of Oerstedt's experiments, Domenico Morichini[3] (1812) magnetized compass needles by means of the ultra-violet portion of the spectrum of sunlight as used by Herschel. His experiments were verified by M. Sommerville[4], F. Zantedeschi[5], V. Baumgartner[6] and others.

We therefore undertook to test the photomagnetic effect also on larger bodies in continuation of the above-mentioned fundamental experiments on submicroscopic bodies (magneto-photophoresis), through which the general magnetization of the elements and the existence of magnetic 'currents' was brought to light. The experiments were successful with the simplest apparatus, undertaken in a private apartment with a 10 cent compass needle from Woolworths as indicator, and using a beam of light rich in ultra-violet radiation (Hanovia mercury arc, Mazda G.E. daylight bulb) which was concentrated by means of quartz lenses (Hanovia, Zeiss).

Magnetic poles (charges) were induced in various non-magnetic and annealed pieces of iron (paper-clips, nails, little iron rods), which were placed perpendicularly to the geomagnetic field, by irradiation for periods varying from minutes to several hours. Those poles were mainly north magnetic and were still present in many specimens after several days.

After short periods of irradiation, it could be shown that the effect was local and on the surface. After long irradiation periods saturation values were obtained.

We also convinced ourselves by means of an amplifier and oscillograph of the Amplifier Company of America that the characteristic of an induction coil with an iron core changed under ultra-violet irradiation.

Naturally, the magnetization was also dependent upon the material, its surface and history to a very high degree. Further investigations are in process.

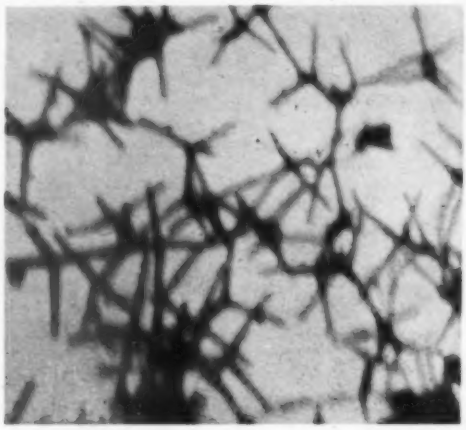
FELIX EHRENHAFT.
LEO BANET.

350 West 58th Street,
New York City.
Dec. 24.

[1] Ehrenhaft, F., *J. Franklin Inst.*, **230**, 381 (1940).
[2] Ehrenhaft, F., NATURE [**146**, 25 (1941)].
[3] Morichini, D., *Gilberts Ann. Phys.*, **43**, 212 (1813); **46**, 367 (1814).
[4] Sommerville, M., *Gilberts Ann. Phys.*, **82**, 493 (1826).
[5] Zantedeschi, F., *Gilberts Ann. Phys.*, **92**, 187 (1829).
[6] Baumgartner, V., *Gilberts Ann. Phys.*, **85**, 508 (1827).

Zinc Oxide Smoke

IN NATURE of December 21, 1940, p. 807, Mr. Fordham has referred to the shape of the particles of zinc oxide smoke, formed by burning zinc in air, as inferred from both optical and electron diffraction data. The accompanying photograph, obtained in this Laboratory by means of the electron microscope[1], confirms his statement that some of the particles are



Zinc Oxide Smoke × 23,000

in the form of needles. The photograph shows that the small crystals of which the smoke consists are about 4,500 A. in length and not more than 450 A. in thickness. There is a remarkable uniformity in the apparent length of the crystals, although there is no reason to suppose that they all lie in one plane.

In the electron microscope we seem to have an instrument capable of yielding interesting information about the shape and size of smoke particles.

G. D. PRESTON.

Metallurgy Department,
National Physical Laboratory,
Teddington.

[1] Martin, Whelpton and Parnum, *J. Sci. Instruments*, **14**, 14 (1937).

Weighing Living Marine Animals

I WAS interested in Dr. Gohar's recent communication on this subject[1].

Living marine animals were weighed by me some years ago and I am actively engaged in this work at Plymouth. The work has been interrupted by the War, and since I am teaching at Rugby I can devote the vacations to it only.

However, the accompanying figures were obtained for the common crab, *Cancer pagurus*, last vacation.

	Width of carapace in cm.	Weight in gm.	Volume in ml.	Density	Sinking factor	Percentage error by direct weighing
Male	10·13	145·08	126·77	1·1445	1112	+3·0
Male	10·5	174·01	142·50	1·2211	1187	+2·5
Male	15·5	630·64	498·58	1·2648	1230	+0·98
Female	11·21	185·53	165·01	1·1243	1091	+2·5

I left all the crabs alive in the aquarium.

By the term *sinking factor* one means the density of the living animal divided by the density of its environment, and to remove decimals the number is multiplied by 1,000.

After the crabs had been weighed accurately they were taken from the sea-water and drained for a minute. They were then transferred to a counterpoised clock-glass and weighed directly.

Though this has been the normal way of weighing a crab before the displacement method was devised, it is clear that with a small crab an error of 3 per cent may occur. With large crabs the percentage error naturally becomes smaller.

Though the work is only in its infancy a great many determinations of a similar character have been made on other animals. The method was fully discussed at a meeting of the Linnean Society and published[2]. A short account was also published in NATURE[3]. This work is being carried on with the aid of a valuable Government grant from the Royal Society and also help from the British Association and the Marine Biological Association.

Actually, Dr. Gohar's method was considered some years ago and discarded on account of the difficulties due to osmosis, since if one either dilutes or concentrates the sea-water one brings about considerable changes in the osmotic pressure of the environment, and one needs scarcely point out that changes in the osmotic pressure of the environment may have very far-reaching effects on the weight, volume, and hence the density of the animal.

This difficulty could be partly overcome by weighing the animal first in sea-water and then in an isotonic solution of sodium nitrate and calcium nitrate.

The displacement method is, however, far more accurate and straightforward and the question of osmosis does not occur, except that the osmotic pressure of the environment must be determined before the experiment.

In a good deal of the work I have had the co-operation of Dr. N. K. Panikkar, while together we have recently weighed a living lobster just after moulting, and determined the osmotic changes which occur and also the alteration in weight, and finally the percentage of water in a young lobster both before and after moulting.

A young dogfish is also being kept alive, and its weight and volume, density, sinking factor, and length noted each vacation.

A. G. LOWNDES.

The Science Laboratories,
Rugby School.

[1] NATURE, **147**, 177 (1941).
[2] *Proc. Linn. Soc.*, Sess. **150**, pp. 62–73 (1938).
[3] NATURE, **141**, 280 (1938).

Science and Government

MR. FINLAY'S letter in NATURE of January 25 reminds us that it is becoming the fashion in some quarters to claim for men of science special qualifications for administration in everyday affairs. This claim seems usually to be based on (*a*) the acknowledged power of the scientific method to demonstrate truth, and (*b*) the readiness of the man of science to accept truth so demonstrated.

Unrestricted experiment, which is a major feature of the scientific method, renders that method

inapplicable in most of our everyday affairs; the well-being of a community cannot be hazarded by an experiment of which the outcome is not a foregone conclusion. Deprived of the discipline imposed by the power of the scientific method, can the scientist rely on his admittedly high professional integrity? Is not this professional integrity a tribute to the compelling power of the scientific method, rather than to the personal integrity of individual men of science? Is there any evidence that in ordinary everyday affairs the man of science differs from his fellows in the degree to which he is a prey to prejudice, obstinacy, and the other common human failings?

If we are deprived of experiment we must fall back on experience, that is, appeal to authority, which is admittedly less satisfying than scientific demonstration; and we cannot, as men of science lacking our chief weapon, expect to prevail in conflict with authority. We are fortunately able to examine a case of organized scientists studying a 'worldly' problem. In 1938 a committee of the Association of Scientific Workers produced a memorandum on the finance of research, being largely a plea for great expansion of research on the grounds that great profit would result. Unfortunately, the committee admitted that neither costs nor benefits of research are measurable, thereby denying the applicability of the scientific method. The memorandum was, therefore, much open to criticism, and finding itself in conflict with authority (the Department of Scientific and Industrial Research), inevitably succumbed.

If there is reason to suppose that scientific workers are not playing their full part in administration, the remedy seems to be that they should enter more fully into 'worldly' responsibilities and arm themselves with authority. There is no new principle, no breaking of tradition, in this; the purest scientist, most impatient of social restraint, is accustomed to publishing his work, thereby voluntarily taking cognisance of society. It is illogical, and therefore unscientific, thereafter to ignore society.

Finally, may I express complete agreement with the article on the cultural significance of science, in NATURE of December 28, 1940? If, by science teaching, we can produce a community schooled to logical and critical thinking, the problem of leadership may well solve itself. An unworthy candidate would less easily pass muster, while men of self-respect might be less reluctant to submit themselves as candidates. Is it too much to hope that some day we shall regard a School Certificate, with credit in mathematics and an exact science, as a minimum qualification for Parliamentary franchise?

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Cambridge.

MAY I be permitted as one of those who were expected to "render their own experience available for the vital task of foreseeing the threats to [the] great heritage of freedom and integrity of thought"[1], to express my view and apprehension concerning the current discussion in these columns about planning, freedom, and science. I think the communication of V. B. Wigglesworth[2] rightly points out that "scientists are human", and not better prepared for leading political positions than other people, and really the dispute about the motivations under which men of science work, or should have to work, shows most clearly that men of science themselves are often exponents of current political opinions, and the authority of 'science', called to witness, is only a fictitious one. With this in view the question whether freedom is in danger if men of science interfere in problems of government is very important indeed, and perhaps a retrospect on similar trends in Germany and Austria, about ten years ago, would not be without interest.

It is quite natural that planning, which is the demand of the hour, finds its strongest advocates among men of science. However, in my opinion a special cause of the decline of the democratic regimes in Central Europe was the ideology of the planned state, the *Stände-staat* (state of estates), which found its best supporters among the scientifically educated intelligentsia. So far as I know the study of this ideology, which was developed especially by Prof. O. Spann[3] in Vienna, and its great influence on the students in universities and technical colleges, has been neglected in the English sociological literature (for example, Mannheim in his book[4] does not mention them), although only by this knowledge can a true understanding of the ideas of the so-called educated people during the rise of fascism be attained, and similar mistakes in the existing democracies prevented. The exponents of the idea of the *Stände-staat* were the scientific experts, the men with a specialized scientific education. Fascinated by planning, and eager to find a secure place in a new hierarchy of society, those men paved, often unaware of the consequences, the way for fascism. Scientific experts are by the whole structure of their present one-sided education easily inclined to become exponents of planning merely for the sake of planning, to follow authoritarian creeds, and so to open the way for political powers which bring in peril not only political freedom, but the freedom of science itself. I cannot help feeling that the political claim of men of science for 'science' in Great Britain and in the United States involves the same idea of organizing 'science' as a special estate, a form of political organization which is incompatible with democracy, and which may become a danger to it.

To propose that men of science should desist from any public activity would certainly be to take a short view. The way of propaganda, however, proposed as a means of enlightening the people about their real benefactors seems only to open the door for pseudo-science, on which ground very strange ideas might develop. Is there no other way open to men of science than to become politicians, no direct approach to help humanity and to bring about the much-quoted new and better world? Of course, there is one, namely co-operation with a liberal and humane educational work, the supreme task of the longed-for state of liberty *and* planning. Here is a task especially for the pure scientists in universities, who, I am afraid, in the existing democracies neglect this part of their professional work, as have done the democratic professor-specialists in the German universities.

OTTO BLÜH.

University of Birmingham,
formerly of
German University of Prague
Feb. 26.

[1] NATURE, **143**, 179 (1939).
[2] NATURE, **147**, 119 (1941).
[3] Spann, Othmar, "Der wahre Staat" (1923).
[4] Mannheim, K., "Man and Society in an Age of Reconstruction" (1940).

RESEARCH ITEMS

Celtic Linch Pin

A FINE enamelled linch pin, British work of the early first century of our era, which was found at King's Langley, Hertfordshire, in 1937, has now been added to the British Museum collections. It is figured and described in *Brit. Mus. Quarterly*, **14**, 4 (1940). It is 5·1 inches in length and has a shank of iron with bronze terminal mounts. That on the head is a splendid crescentic ornament inlaid with a red enamel. The pin itself has a creamy-green putina. The scroll pattern of the field is conventionalized almost to the ultimate stage of transformation into geometric, but this in no way detracts from the fluent gracefulness of Celtic art. The contained design is exactly adjusted to the sweeping contour of the head. What is at first sight a central circular medallion is really the spiraliform volute of a scroll, with asymmetric manipulation of detail to give the effect of a fold-over symmetry—an achievement in which Celtic artists took special delight. This is illustrated in a number of pieces of about the same date, one of the most notable examples being the Desborough Mirror, also in the Museum collections. The linch pin recently has been described as "a late and eccentric version of the type that was introduced into Yorkshire by the Parisii in the mid-third century B.C."

A Classification of Birds

THE earlier edition of his revision of the "Classification of the Birds of the World" (1934) having become exhausted, Alexander Wetmore has published a new edition (*Smiths. Misc. Coll.*, **99**, No. 7; 1940). There are relatively few changes in the new grouping: the fossil forms Baptornis and Apatornis have had special families allocated to them, and among the Anseres is included a new family, Paranyrocidæ, for a fossil from the Lower Miocene of South Dakota. Instead of associating the osprey Pandion with the Cathartæ, as L. V. Compton suggested, Wetmore follows the more conservative plan of placing Pandionidæ in the superfamily Falconoidea, considering that the resemblances between the ospreys and New World vultures, upon which Compton placed emphasis, are more likely due to convergence than to genetic relationship.

Geographical Distribution of Opalinid Infusorians

IN his latest study of the opalinid ciliate infusorians, which revises and extends a previous U.S. National Museum Bulletin on the group, Maynard M. Metcalf describes thirty new species and sub-species, and traces with high probability the course of the evolution of the family, unifying facts derived from comparative anatomy, development and geographical distribution in proving "the phylogeny beyond reasonable doubt" (*Proc. U.S. Nat. Mus.*, **87**, 465–634; 1940). In addition, he sets an example to the specialist by deriving from his detailed studies information of great general interest. Thus he has plotted on maps the distribution of different opalinid genera and species, and has associated this knowledge with the distribution of their hosts in an effort to trace the places of origin, the times of origin, and the routes by which hosts and parasites arrived at their present-day dispersal. The general result is that the data derived from opalinids and anurans fit harmoniously with the hypotheses of paleocartographers, such as Arldt and Schuchert, regarding the relationships of land masses in the past, the only discrepancy being that the opalinid facts seem to demand a connexion between Asia-Malaysia and Lemuria during the Jurassic or early Cretaceous periods. The author concludes that the Pleistocene glacial period came too late to be of much significance in connexion with the evolution and distribution of the Anura and their opalinids, most of the evolution of both having taken place long before Pleistocene times.

New Zealand Dobson-fly

AVICE HAMILTON has recently described the life-cycle of the common New Zealand Dobson-fly (*Archichauliodes diversus* Walk) (*New Zealand J. Sci. and Tech.*, **23**, A; 1940). This insect, it may be added, is the only member of the suborder Megaloptera in New Zealand and is closely related to the single Australian species *A. guttiferus*. The eggs are deposited in irregular masses on rocks and trees that overhang streams, and the incubation period is about 30 days. The larva is aquatic and each of its first eight abdominal segments bears a pair of unsegmental conical filaments containing branched tracheæ. These filaments are evidently gills, and respiration is stated mainly to be effected by diffusion through their cuticular covering. There are in addition ten pairs of spiracles, but whether these are functional or not is unstated. The food of the larvæ consists mainly of the nymphs of may-flies that are plentiful in the streams that they inhabit. Both prepupal and pupal instars are described. The imago, which is a relatively large insect, lives only six to ten days and has not been observed to feed. The species occurs commonly throughout the country and is often abundant in localized areas. The larvæ serve as food for trout and other freshwater fish.

Soils and Afforestation

AT the request of the Forestry Commission, Muir and Frazer have carried out a soil and vegetation survey of an area of diverse geology some forty miles to the north-west of Aberdeen, which is undergoing afforestation. With the aid of H. M. Steven the results of this investigation have been presented (*Trans. Roy. Soc. Edin.*, **60**, No. 8; 1940), in association with a statement of the current views, on the basis of the Commission's experience, on the choice of tree species suitable for planting on the different soil types in the given climatic conditions. Soils of the podzol group are represented, derived in general from the more acid (geologically) parent materials; the basic igneous rocks give usually soils of the 'brown earth' type. No correlation is observed between the depth of the bleached horizon of the podzols and the rainfall. Grassland is the more frequent vegetation in the 'brown earth' soils; but in the district generally heath and moorland types prevail, dry heath on the acid soils, wet heath and moorland on the soils derived from the heavier basic rock materials.

Inversions in Tradescantia

C. R. SWANSON (*Genetics*, **25**, 438–465; 1940) has shown that a hybrid population of Tradescantia resulting from the natural hybrids of *T. canaliculata* and *T. humilis* contains a considerable number of inversions in the chromosomes. There is a high correlation between number of interstitial chiasmata and number of inversions. This is taken as evidence that interstitial inversions are numerous but are usually undetected where the chiasma-frequency is low and localized. With hybridity, genes controlling pairing at meiosis recombine and may induce pairing of parts of chromosomes which otherwise were isolated. Pairing in chromosomes of Tradescantia begins at the distal end of the chromosomes. The phylogenetical aspects of the data are discussed and it is shown that self-incompatibility favours gene recombination, while inversions and chiasma localization act as barriers to recombination. Where self-sterility genes lie close to inversions they tend to aid the perpetuation of inversion heterozygosity.

Spontaneous Chromosome Change

C. D. Darlington and M. B. Upcott (*J. Genetics*, 41, 297–328; 1941) have analysed spontaneous structural alterations in the chromosomes of Tulipa Hyacinthus and Tradescantia. In many respects these changes are similar to those induced by X-ray radiation. It is therefore possible to discuss the reasons for the diversity of the results of such changes. For example, the frequent occurrence of small acentric rings, attributed to two breaks initiated by one hit, are more probably the result of two breaks followed by preferential union between non-sister chromatids. Similarly it is probable that the diverse results of induced exchange are due to the diversity in the conditions of reunion. Further, reunions between broken ends of sister chromatids and sometimes between non-sister chromatids may take place many cell generations after breakage. The experimental dosage frequency of changes and fractionation effects are therefore interpreted by the competition in types of reunion and not by the frequency of types of break initiated by a hit. The authors also point out that the new interpretation emphasizes that chromosome splitting is uniform and takes place late in the intermitotic resting stage.

Thermal Conductivity of Rocks

KNOWLEDGE of the thermal conductivity of the materials of the earth's crust and its dependence upon temperature is required for the quantitative treatment of numerous problems of geology and geophysics. F. Birch and H. Clark (*Amer. J. Sci.*, **238**, 529; 1940) describe an apparatus for the measurement of conductivity between 0° and 500° C. and present results for 18 igneous rocks, 7 sedimentary and metamorphic rocks, 3 single crystals and 4 glasses. At 0° C. the conductivities of all of the rocks lie between 0·014 and 0·004 in c.g.s. units; at 200° C. all lie between 0·009 and 0·004. The conductivities of the poorest conductors, the felspar aggregates and the glasses, increase with temperature, whereas those of all the other crystalline materials decrease. The highest conductivities are found for the ultrabasic rocks, hitherto unstudied, but here, as with other rocks, the variation is such that the values tend to converge as the temperature increases. While the differences are important at the temperatures at which measurements of geothermal gradients are made, they become much less so at depths within the crust of the order 10–20 km. A simple method of computation permits a calculation of the conductivity of fresh igneous rocks in terms of their mineral composition with an error usually less than five per cent at temperatures up to 200° C. This method may prove useful in the discussion of gradients and heat flow in rocks the conductivities of which have not been measured. An interesting example is a gradient of 144–170 metres/° C. in a Russian occurrence of pyroxenite and peridotite; from this the heat flow may be estimated at about $0{\cdot}8 \times 10^{-6}$ cal./cm./sec., in fair agreement with the results of Benfield in Britain and Bullard in South Africa.

Stereochemical Types and Valency Groups

THE Bakerian Lecture by N. V. Sidgwick and H. M. Powell (*Proc. Roy. Soc.*, A, **176**, 153–180; 1940) deals with stereochemical types and valency groups, and illustrates the advantages of having alternative ways of grouping the same set of facts. Experiments on X-ray and electron diffraction, absorption and Raman spectra, optical activity and electrical dipole moment have produced data of interest to both physicist and chemist. So far, the treatment of the results in theoretical physics has linked up the stereochemistry of the molecule with the number of shared and unshared electrons in the polyvalent atom, and the electronic sub-groups which these occupy. Unfortunately for the chemist, when the energy differences between the various possible electronic arrangements, or between various stereochemical groupings which are compatible with the same electronic structure, are small, they cannot be determined by calculation. Thus, possible instead of actual arrangements are predicted. Furthermore, the chemist cannot always tell whether the bands in a given molecule are *s*, *p*, or *d*, even when this is clear to the physicist. An attempt is therefore made to relate the data to some property of the molecule with which the chemist is more familiar. The arrangements in space of the covalencies of a polyvalent atom, while they are subject to small variations, seldom exceeding 5° or 10°, tend to conform to quite a limited number of types. By using the size (in G. N. Lewis's sense) of the valency group of the central atom, and the number of shared electrons which it contains, together with that of the preceding (unshared) electronic group in the atom, the authors are able to fit the experimental results into eight relationships (see NATURE, July 13, 1940, p. 70). The bibliography at the end of the paper covers fifteen pages.

Flame Spectrum of Carbon Monoxide

APART from the complexity of the spectrum of the flame of carbon monoxide burning in air or oxygen, great difficulty has been found in interpretation because of the weakness of the bands relative to the continuous background. The results of an improved technique have been reported recently by A. G. Gaydon (*Proc. Roy. Soc.*, A, **176**, 505–21; 1940). Whereas previous workers had used relatively fast photographic plates with low contrast, plates of the highest contrast were used in the present investigation. The improvement in contrast has enabled new measurements of the spectrum to be made, and the structure of the band system and its origin are dealt with in the light of the more recent developments in knowledge of molecular structure.

THE AUSTRALIAN NATIONAL STANDARDS LABORATORY

By SIR DAVID RIVETT, K.C.M.G.

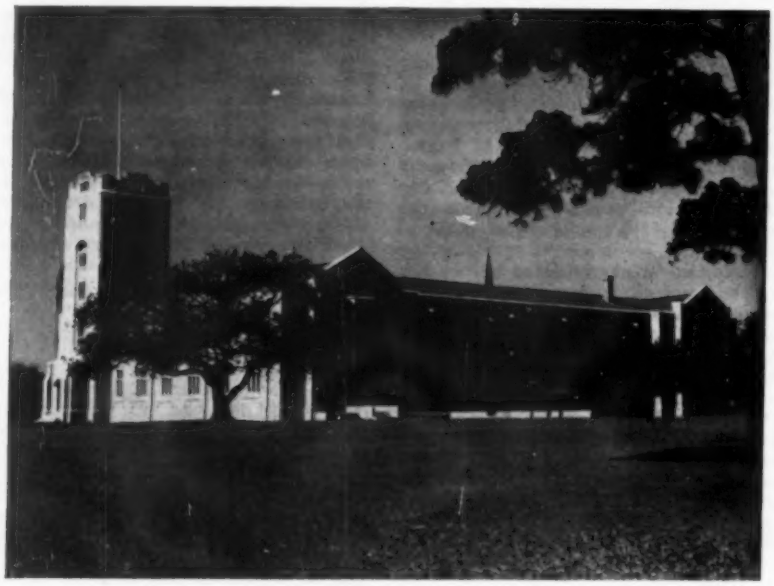
COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

WITH the help of the Department of Scientific and Industrial Research, a plan for a Standards Laboratory in Australia was drawn up in 1927, to be controlled by the recently created Council for Scientific and Industrial Research. Unfortunately, the need for it was not fully realized in political circles until, after ten years or more, the growth of secondary industries and an impending acceleration due to war activity, made further postponement obviously dangerous.

Rapid progress has been made in the past eighteen months and a handsome building has now been completed on a site generously provided in its grounds by the University of Sydney. The front (eastern) elevation is faced with white Hawkesbury sandstone to fit in with the general architectural scheme of the main frontage of the University; the sides and back are treated with light-coloured brick and stone trimmings.

With two stories and a basement in front and three stories and basement behind, the total floor space available is 80,000 sq. ft. Besides laboratories and test rooms for the usual three sections of metrology, electro-technology and physics, there is adequate provision for general offices, workshops and a library. Many of the rooms, including a 130-ft. tape tunnel, are air-conditioned, the plant being designed to maintain a temperature of 68° F. ±1° at bench height.

Particular attention has been paid to the problem of means to run special electrical or other services from one room to another. Vertical ducts to every alternate room and horizontal ducts along the external walls serve this purpose. In addition, numbers of 2-in. diameter pipes have been embedded in the reinforced concrete floors to provide passage between rooms on opposite sides of corridors.



AUSTRALIAN NATIONAL STANDARDS LABORATORY, SYDNEY

The laboratory will hold all national standards for the Commonwealth and will, of course, maintain intimate contact with the National Physical Laboratory at Teddington, which during the past two years has extended its hospitality to some nine officers for purposes of general experience in the calibration and use of instruments. It is the intention to establish substandards laboratories, under State Government control, in certain of the capital cities, to carry testing work beyond the stage to which it will be taken by the National Standards Laboratory.

Considering existing difficulties in obtaining equipment, the Council has been fortunate in securing the instruments and workshop machines which are now in its possession.

The building, which cost £100,000, will for the present house certain other activities of the Council for Scientific and Industrial Research in physics, as well as the normal standards services.

COLOUR TOLERANCE

ON February 12, the Physical Society Colour Group held its inaugural meeting at the Regent Street Polytechnic, London. In accepting the responsibility for the formation of this group, the Physical Society hopes to provide a valuable opportunity for people interested in colour, whether as physicists, chemists, dyers, industrialists or otherwise, to meet for their mutual benefit. A number of societies have already agreed to co-operate by becoming founder societies of the group and, in addition to the Physical Society, these include the British Kinematograph Society, the Illuminating Engineering Society, the Institute of Physics, the Royal Photographic Society, the Society of Glass Technology, the Society of Dyers and Colourists, and the Oil and Colour Chemists' Association.

The opening meeting was in part occupied by a discussion of the constitution of the Group, but when this had been formally adopted, a discussion on "Colour Tolerance" was held. Such a subject presents a very wide field, and was chosen intentionally for the opening meeting so as to interest as many people as possible and to provide an opportunity for each type of worker to become acquainted with the others.

In a brief introduction, it was shown that the problems of colour tolerance can be divided roughly into three, namely, the commercial aspect, in which the requirements of the customer have to be considered, the technical aspect, in which the limitations of manufacturing processes have to be taken into account, and the physical aspect, in which the specification and measurement of colour tolerances must be discussed.

Mr. R. F. Wilson, of the British Colour Council, in dealing with the commercial side of the problem, showed how valuable it is to limit the number of colours employed in any particular industry to the minimum that will satisfy the general public. In this way manufacturing costs can be very materially reduced and the irritating task of trying to differentiate between colours that in fact possess only minute differences, can be avoided. Remarkable figures for the number of colours that were used until recently in various cases, as, for example, in stockings and in the dyeing of the soles of ladies' shoes, were quoted during the discussion. Mr. Wilson also referred to the importance of the lighting on the accuracy to which colours can be matched, and appealed for more uniform lighting conditions. He instanced the case of a firm that has an excellently equipped viewing room and yet often encounters difficulties because the very perfection of its lighting arrangements is so different from that employed by the retailer. The question of a standard daylight lamp was raised by several speakers, while it was also pointed out that for many purposes, of which theatre lighting and interior decoration may be cited, artificial lighting is more important, so that a standard artificial lamp is also very desirable.

A point raised by Mr. Wilson and echoed by other speakers was the often serious trouble that arises when persons with defective colour vision are employed in colour industries. Colour-blindness may be regarded as a somewhat extreme case; but it is evident that even slightly abnormal vision may affect the ability of an observer to detect small colour differences correctly.

Mr. H. W. Ellis, of the Clayton Aniline Co., dealt with the technical limitations of dyeing processes and in his paper he demonstrated how the limits to which the dyer should be asked to work ought to be determined very closely by the purpose to which a dyed material is to be put. A material may sometimes have to be made fast to light, sometimes to washing, sometimes to the effects of perspiration and so on, but only in exceptional cases would the expense of using a dye fast under all conditions be justified. Thus while curtain material should be fast to light, this is of little importance in the case of ladies' underwear, which must, however, be made fast to washing.

Again, it may happen that the colour of a surface varies according to the direction in which it is viewed, and when several different viewing angles are presented simultaneously, as for example with hats, it becomes important that the change in colour with angle should be held within close limits. Samples were also shown to demonstrate the change in colour that results with given changes in the chemical conditions of dyeing; but perhaps the most striking feature of Mr. Ellis's paper was the evidence it afforded that tolerance questions may arise in many and varied forms.

Mr. J. W. Perry, of Messrs. Adam Hilger, Ltd., had the task of discussing the physical aspect of colour tolerances. He indicated how tolerances can be expressed in the standard C.I.E. chart or, if desired, on an oblique projection of the chart known as the rectangular uniform chromaticity scale (R.U.C.S.), and then developed equations from which the tolerance, defined initially in terms of the additive primaries of the C.I.E. system, can be transformed into the terms of the subtractive primaries of the dyer. One of the greatest difficulties, and one of the greatest opportunities, for the Colour Group, will be to bridge the gap between the additive colour mixture familiar to the physicist and the subtractive colour mixture always employed by the dyer. This is unfortunately a by no means simple matter and it has the, to the dyer, added disadvantage of requiring a fair amount of mathematics. Mr. Perry did not spare the chemists and dyers, and later in the meeting urged that each member of the Group should be prepared to make the mental effort required to understand the approach of other members to the problems of colour. At the same time, those taking part in the discussion must bear in mind that many of their audience have been trained along very different lines from their own and they, too, should make an effort to express themselves in the simplest possible manner.

It was inevitable that at the opening meeting a number of points would arise that had little direct bearing on colour tolerance, and it was especially interesting to notice how frequently references to colour-blindness occurred, suggestions being made

that a test for colour-blindness should be instituted in schools. The effect of eyestrain when using instruments, the sensitivity of the unaided eye in detecting small colour differences compared with the sensitivity when a colorimeter is employed, the mathematical developments of colorimetry in the United States, the merits of spectrophotometers, all came in for some comment. The excellent attendance, the interest of the members and the wealth of material as subjects for discussion, augur well for the future of the Group.

ELECTRICALLY DRIVEN SHIPS

IN war-time, while the question of capital cost is not the most important consideration, anything which increases the tonnage of the Navy and of the merchant fleet deserves serious attention. During the War of 1914–18, the attempts of the German Navy to blockade the British Isles by the unrestricted use of the submarine presented a similar problem. It was solved by the adoption of entirely novel methods. In addition to methods of speeding up ships of conventional design, the so-called 'fabricated' ship was constructed, and bridge builders and constructional engineers were called in to help. The parts of the hull were constructed, usually inland, and were sent to a convenient location on the coast where they were erected and launched.

In the *Electrical Review* of January 24, Mr. A. Regnauld makes a useful contribution to the solution of the problem by pointing out that ships' output can be increased by increasing their speed. This can be done by utilizing the large available electrical manufacturing industry for the production of the propelling machinery, and leaving the shipyards to deal with the production of the hulls.

In present circumstances, the manufacture of electric generating equipment is largely in abeyance and so also is the production of prime movers. If the shipyards could increase the output of hulls, the propelling equipment for the additional vessels could be constructed in its entirety by the electrical manufacturers and associated boiler manufacturers when steam turbines are installed. In all modern turbo-driven steamships, some form of speed-reducing gearing must be employed. The most efficient propeller speed for merchant tonnage, namely, 12–15 knots, is 100–120 r.p.m. The economic speed of the steam turbine is very high, somewhere about 3,000 r.p.m., varying according to size. Neither the turbine nor the heavy-oil engine can be readily reversed. This involves the use of specially constructed turbines running in the reverse direction to the main turbines. These astern turbines are often of sufficient size to develop more than 50 per cent of the ahead power. They may only be required for half an hour or so, at the beginning and end of a voyage when manœuvring out of and into port. This represents a very uneconomical effect.

With the electric drive, particularly if two or more generators are employed to supply the maximum power, a very high degree of flexibility is obtained at all the different speeds used in service. If bridge control be fitted, it would prove of supreme value in any emergency which might arise. The maintenance charges comprised of overhauls and repairs are generally in favour of the electrically driven ship.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

Saturday, March 8

SOCIETY FOR CULTURAL RELATIONS WITH THE U.S.S.R. (at the Royal Hotel, Woburn Place, London, W.C.1), at 1 p.m.—Prof. George Thomson: "Anthropological Theory in the U.S.S.R."

Monday, March 10

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. Gerald Seligman: "The Structure of a Temperate Glacier".

Tuesday, March 11

CHEMICAL ENGINEERING GROUP in conjunction with the INSTITUTION OF CHEMICAL ENGINEERS (Joint Meeting) (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1.), at 2.30 p.m.—Mr. E. W. Murray: "Ventilation (Natural and Artificial) in relation to the Blackout".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Addresses on "Recent Work on A.R.P. Lighting Problems."

Wednesday, March 12

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual Meeting. Prof. P. G. H. Boswell, F.R.S.: Presidential Address—Part 1: "The Status of Geology, a Review of Present Conditions"; Part 2: "The Stability of Minerals in Sedimentary Rocks".

Friday, March 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1.) at 3 p.m. Annual General Meeting. Professor H. C. Plummer, F.R.S.: "The History of the Vertical Telescope."

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. J. Calderwood: "Some General Observations on Vibration".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER FOR MECHANICAL ENGINEERING SUBJECTS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (March 17).

DEMONSTRATOR® IN BIOLOGY—The Principal, Technical College, Kingston-upon-Thames.

ASSISTANT PROFESSOR OF METALLURGY—The Director, Department of Mining and Metallurgical Engineering, Laval University, Quebec City, Canada.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Finance and the War. An Address given by Prof. F. Soddy to Members of the Parliamentary Labour Party at the House of Commons on Tuesday, November 9, 1940. Pp 16. (London: Economic Reform Club and Institute.) 3d. [29]

Report on Conditions in Reception Areas. By a Committee under the Chairmanship of Mr. Geoffrey Shakespeare, M.P. Pp. 18. (London: H.M. Stationery Office.) 2d. net. [29]

Tin Research Institute. Publication No. 102: Hot-Tinning; an Account of the Tinning of Steel, Iron, Copper, Brass and Bronze by the Hot-dipping Process. By Dr. C. E. Homer. Pp. 28. (Greenford: Tin Research Institute.) [29]

Other Countries

Publications of the Allegheny Observatory of the University of Pittsburgh. Vol. 8, No. 5: Observations of Eros, 1930–1931. By N. E. Wagman. Pp. 63–76. (Pittsburgh, Pa.: University of Pittsburgh Press.) [29]

Government of Bengal: Department of Agriculture and Fisheries. Report on a Survey of the Fisheries of Bengal. Pp. iii+88. (Alipore: Bengal Government Press.) [29]